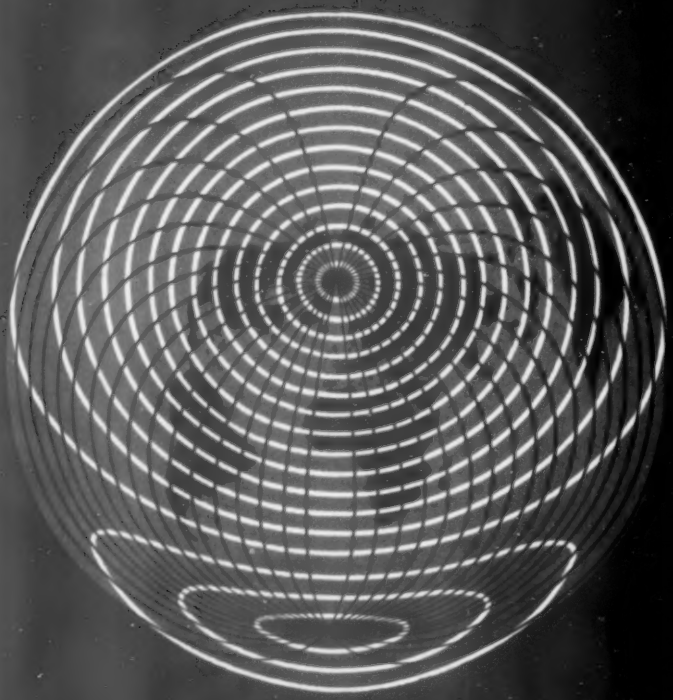
Wireless World

ELECTRONICS



2 new Stabilised Power Supply Units

Three stabilised voltage outputs are provided by each of the two new Ediswan Power Supply Units Types R.1260 and R.1280. In each case two major D.C. outputs variable from 0 to 300v. are provided, plus a low current—D.C. output of reverse polarity.

These units are very suitable power sources for experimental electronic circuits and can frequently be used in place of several single power supplies.

Both units work from normal A.C. mains supply and are designed for standard 19" rack mounting or for bench use. Meters are included.

SPECIFICATION

Input
200-250v., 40-100 C.P.S.

Outputs

1. High stability D.C. output 0 to 300v. in one range.
   Maximum current: type R.1260 75mA
   type R.1280 150mA
2. High stability D.C. output 0 to 300v. in one range.
   Maximum current (both types) 75mA
3. High stability D.C. output -200v. non-variable.
   Maximum current (both types) 25mA

4 and 5. Two independent 6.3v. 4 amp A.C. unstabilised outputs, both centre tapped.

Notes:

A. The negative terminals of the two 300v. supplies and the positive terminal of the 200v. supply are common.

B. Either output 1 or 2 may be taken with output 3 to give a supply of 200-500v. at 25mA.

Stability
With change of mains input voltage (outputs 1, 2 and 3):
A change of 10v. in the mains supply results in an output change of less than 0.1v.
With change of load: A change from zero to full load results in output voltage changes as follows:

Outputs 1 and 2	Less than 0.3v.
Output 3	Less than 0.1v.

Output Resistance (Outputs 1, 2 and 3).
Less than 3 ohms.

Ripple

Outputs 1 and 2	Less than 2mV R.M.S.
Output 3	Less than 4mV R.M.S.

Output Circuits
All outputs isolated from earth, and any point may be connected to earth. All terminals can be worked at up to 500 volts from earth. Outputs 1 and 2 may be switched without affecting any of the heater supplies.

Meters
Each 300v. supply has a meter which can be switched to be a voltmeter or milliammeter.

Mounting
R.1260 and R.1280 are both suitable for standard 19" rack mounting, or for bench use.

Price
R.1260—£78 nett
R.1280—£86 nett
Bench stand for R.1280—£2 nett

Further information on this and other Ediswan Stabilised Power Supply Units on request.

EDISWAN
RADIO DIVISION

8P132

THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2
Member of the A.E.I. Group of Companies.
Telephone: Gerrard 8660 Telegrams: Ediswan, Westcent, London

Two new AVO Signal Generators...

Regd. Trade Mark

FOR BANDS I, II & III
...ON FUNDAMENTALS

The "AVO" Signal Generator Type III

An inexpensive A.M. Signal Generator of entirely new design, for the Service Engineer. Provides six frequency bands covering 150 kc/s — 220 Mc/s. Accuracy ± 1%.

150 kc/s	—	500 kc/s	*Continuous wave or modulated at 1,000c/s. L.F. signal available for test purposes.*
500 kc/s	—	1.6 Mc/s	
1.6 Mc/s	—	5.5 Mc/s	
5.5 Mc/s	—	18 Mc/s	
18 Mc/s	—	70 Mc/s	
70 Mc/s	—	220 Mc/s	

A new type of attenuator, ensures close adherence of the output to the attenuator calibration. The instrument provides a force output of 250mV, whilst the following outputs are available via the attenuator:—

Minimum to 100 μV, x 1, x 10, x 100, x 1000.
Output impedances—80Ω, 200Ω and 400Ω.

List Price **£29**

The "AVO" Wide Band A.M./F.M. Signal Generator (Type T.F.M.)

Designed primarily for the television and F.M. Engineer, this instrument incorporates a number of additional refinements to enable it to deal satisfactorily with the very stringent requirements of the new bands.

A.M. Coverage:	5 — 220 Mc/s. in 8 ranges, CW or 400 c/s sine/square wave modulation. Accuracy ± 1%. Provision for spot frequency calibration.
F.M. Coverage:	65 — 120 Mc/s. Accuracy ± 1%. Maximum deviation ± 150 kc/s.
Output:	Minimum (about 2 μV) to 100 mV continuously variable with decade multiplier. Force output 250 mV.
Output Impedance:	80Ω, 200Ω, balanced 80Ω and 300Ω.

L.F. signal is available for test purposes, and the instrument can be modulated from an external source (A.M. only). A double-ratio slow-motion mechanism, together with interpolation dial, enables the instrument to be set with a high degree of accuracy. On the F.M. range an internal phasing control enables the modulating signal to be applied to the X-plates of an oscillograph to produce a picture of a discriminator response curve.

Price to be announced.

Both instruments operate from 100—120, 200—260V, 50—60 c/s A.C. Mains. They are light and compact, and employ double screening to ensure minimum radiation.

Full details of both instruments available on request.

Sole Proprietors and Manufacturers:—

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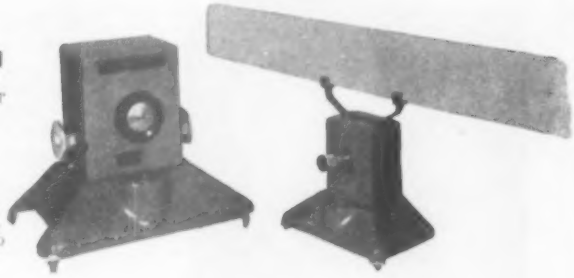
X-BAND MICROWAVE WATTMETER — TYPE U.181

A feed-through torque vane wattmeter for absolute measurement of power in the wavelength range 3.05 to 3.45 cms. It will measure power in the range 1 to 100W or the equivalent mean of pulsed power. Accuracy between 100 and 10 watts is ± 2% falling to ± 10% at 1 watt. VSWR better than 0.9.

Price £275 net ex works



R.F. BRIDGE — TYPE B.601 15 Kc/s TO 5 Mc/s

A highly accurate transformer ratio arm bridge for the measurement of capacitance, resistance and inductance within the range 0.01 pF to 0.02 μF, 10Ω to 10 MΩ and 0.5 μH to 50 mH. It can be used to measure complex impedances, balanced or unbalanced, or between any pair of terminals in delta formation.

Price £125 net ex works.

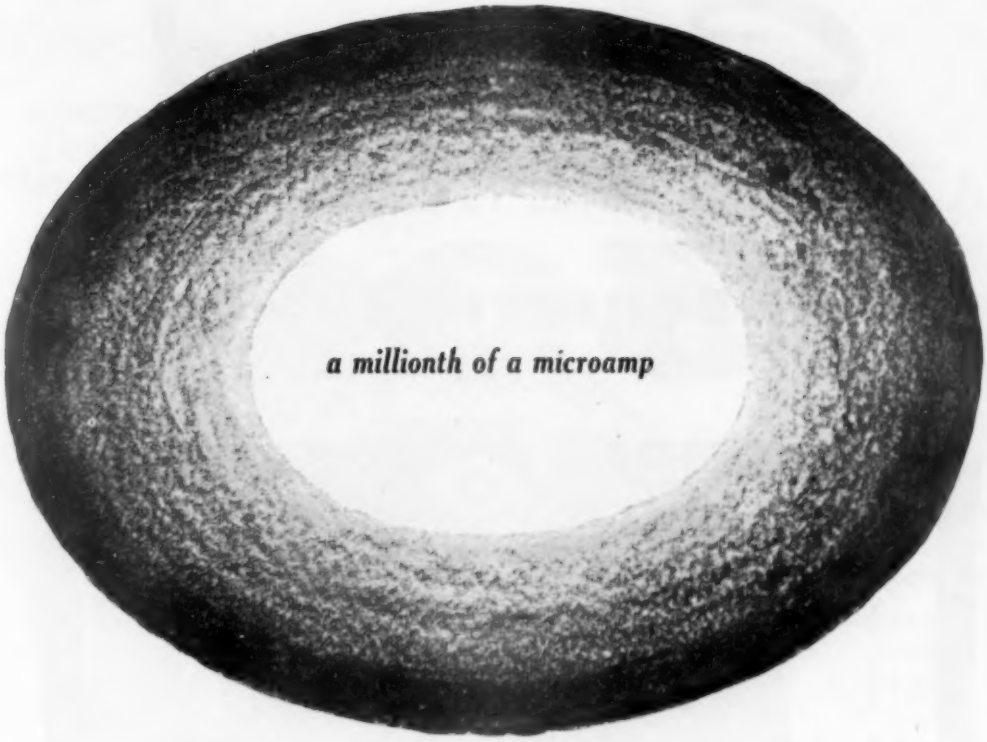
VIDEO OSCILLATOR — TYPE 0.22B

A portable instrument covering the range 10 Kc/s to 10 Mc/s with an output of +10 dbs to —50 dbs on 1 volt p. to p. amplitude stabilised to 0·5 dbs over its full frequency range. It includes a 50 cps. square wave output and facilities for direct reading of the modulus of the load impedance.

Price : Portable £165 net ex works
Rack mounted £158 net ex works.

FOR FURTHER DETAILS WRITE OR TELEPHONE

THE WAYNE KERR LABORATORIES LTD · NEW MALDEN · SURREY MALDEN 2202



A millionth of a microamp can be measured easily and accurately with Mullard electrometer valves. These valves have such an extremely low grid current, and consequently high input resistance, that they extend the scope of electronic measurement of small currents down to the region of 10^{-15} amp.

Type No.	Construction	V_a (V)	g_m (μA/V)	μ	I_g (A)
ME 1400 (CV 432)	Pentode on octal base	45	240	—	$I_{g1} < 10^{-11}$
ME 1401 (CV 495)	Subminiature triode	9	80	20	$I_g < 12.5 \times 10^{-14}$
*ME 1402 (CV 2730)	Subminiature tetrode	45	17 (a-g_2)	1·2 (a-g_2)	$I_{g2} < 6 \times 10^{-15}$
ME 1403 (CV 2348)	Subminiature pentode	10	10·5	110 (a-g_1)	$I_{g1} < 8 \times 10^{-15}$

*Primarily intended as a maintenance type and not recommended for new equipment.

The valves described above include types for almost every electrometer application and are widely employed in valve voltmeters, pH meters, photocell units, nuclear instruments and numerous other equipments in industry and research.

Mullard *Electrometer valves*

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Mullard Limited, Communications and Industrial Valve Department, Century House, Shaftesbury Avenue, W.C.2.

MVT 209

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Wow and Flutter have been reduced to the minimum, being less than 0.2% and less than 0.05% respectively. The unit is equipped for dual voltage ranges of 100 to 130 and 200 to 250 volts, 50 or 60 cycles according to the motor pulley fitted.

The Model 301 is finished in high quality grey tone enamel, is fully tropicalised and is supplied complete with a plastic stroboscope, a tube of special grease, all fixing screws, washers, template and instruction manual.

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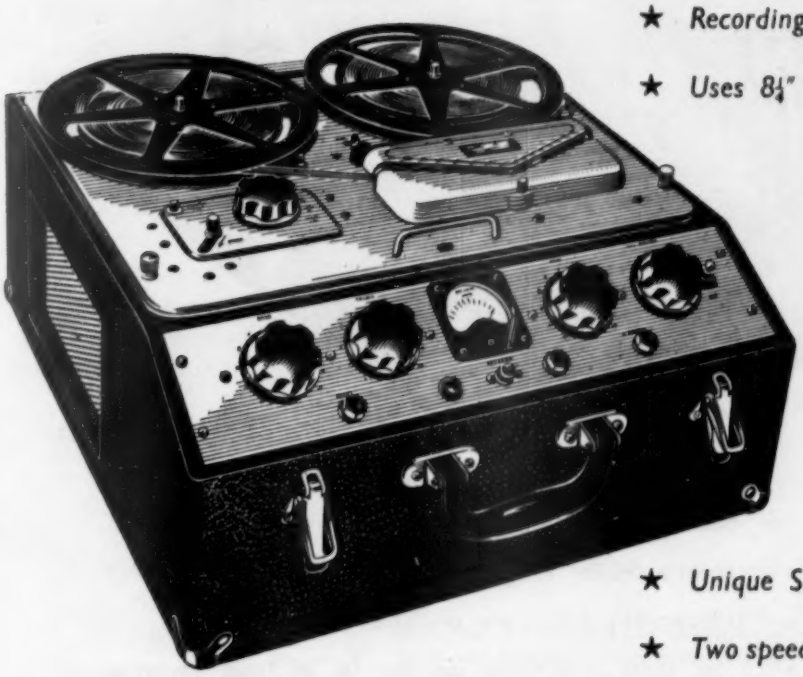
★ *Recording level Meter*

★ *Uses 8¼" dia. Reels*



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The Ferrograph was the first Tape Recorder ever to be designed and wholly manufactured in Britain. That was in 1949. To-day its reputation stands higher than ever. Few indeed are the countries to which it is not being regularly exported. And what is the secret of its success? Surely it is this. From the beginning we have had but one aim: to make the finest Tape Recorder that this country, with its wealth of technical skill, can turn out. Not for us the ambition to make the greatest quantity—or the widest range of types—or even to cater for all pockets. On the contrary, we believe that for a Tape Recorder to give lasting satisfaction it must be an instrument of the utmost precision that needs a great deal of critical and unhurried supervision at every stage of its manufacture. Ferrograph users appear to agree with the simple philosophy that there can be no compromise with quality.

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THIS instrument is a standard signal generator of very moderate cost operating over the frequency range 30 c/s–30 Mc/s. The use of a tuned buffer circuit which operates on all ranges helps to reduce harmonic distortion and ensures that the oscillator frequency is independent of the setting of the output and attenuator controls. Special features include a completely stabilised output level over the entire frequency range and the provision of a high voltage output.

SPECIFICATION

Frequency Range:	30 kc/s–30 Mc/s
Output Level:	1.1 volts open circuit
Output Level Stabilisation:	Constant to within 1 db over entire frequency range
Attenuators:	A 75 ohm slide wire and step attenuator calibrated in db and volts open circuit enable the output to be reduced to 1 microvolt
External Field:	Less than 1 microvolt per metre at a distance of 1ft
High Output:	A signal voltage of from 5–20 volts is available from a separate 300 ohm output socket

Full details of this or any other Airmec instrument will be forwarded gladly on request

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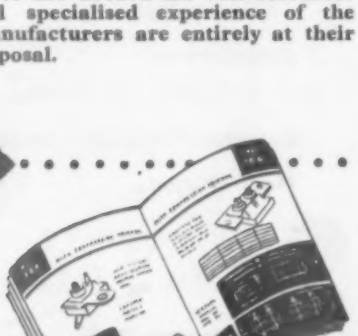

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- ★ Heats up from cold in 6 seconds—by a light thumb pressure on the switch ring.
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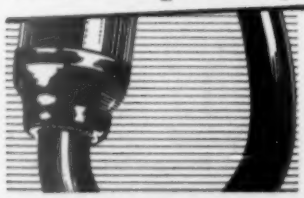

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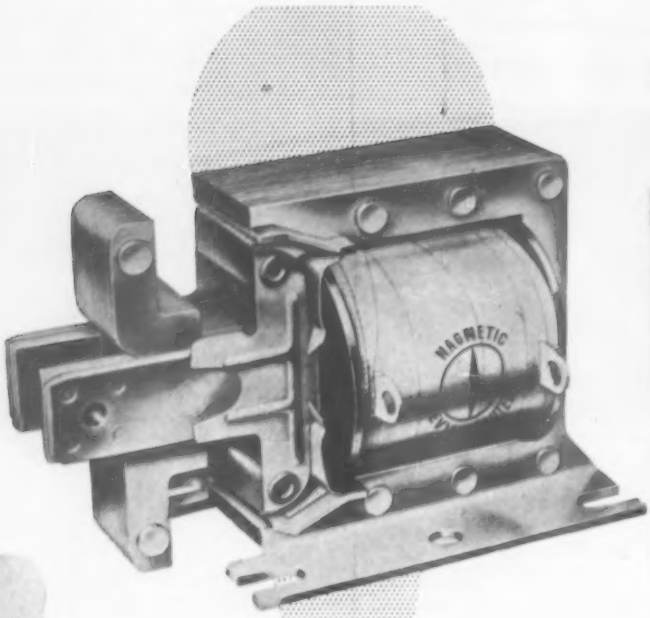

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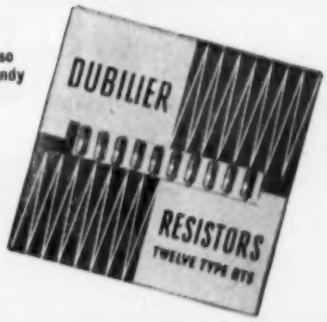
Type BT insulated resistors are completely protected by a phenolic resin housing which is sealed at the ends. Type BTS is rated at ½ watt and Type BTB at 1 watt at 70° C. Resistance range is 100Ω to 10MΩ (BTS) and 390Ω to 22MΩ (BTB).

Type BTS resistors are also available in attractive handy cartons of twelve. These cartons protect the resistors from dirt and permit easy storage and selection in the laboratory or workshop. Save time and trouble by ordering all your ½ watt resistors in the handy carton.



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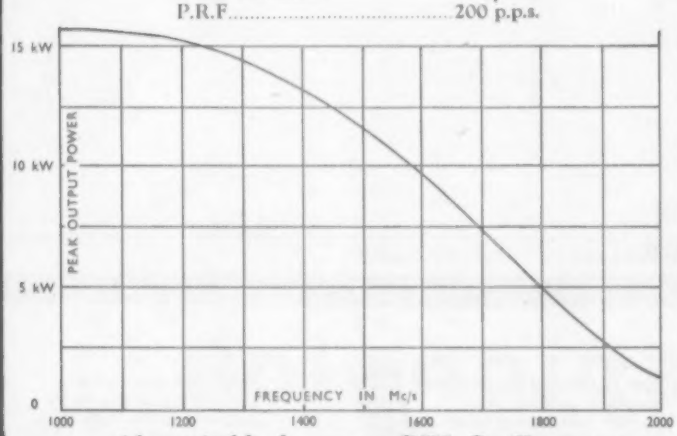

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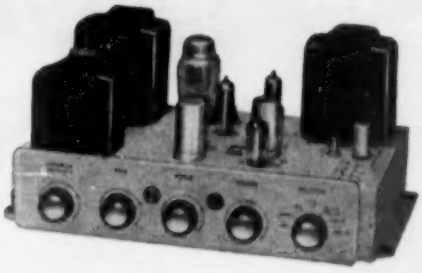

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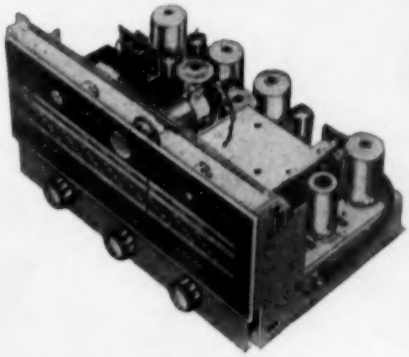
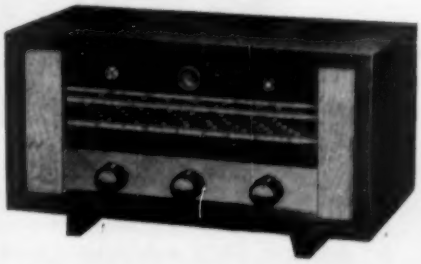


HFT111 Tuner.—An advanced 8-valve FM/AM tuner with built-in power pack designed to give high fidelity reproduction when used with amplifying equipment of comparable quality. Features: a stabilised permeability tuning system, noise limiter and phase discriminator. Attenuators provided for both FM and AM outputs.



HFT111W Tuner (Cabinet).—This houses the HFT111 Tuner in a contemporary style cabinet of contrasting sycamore and walnut veneers; it has been specially designed to match the finish of other high fidelity units in the Pye range.

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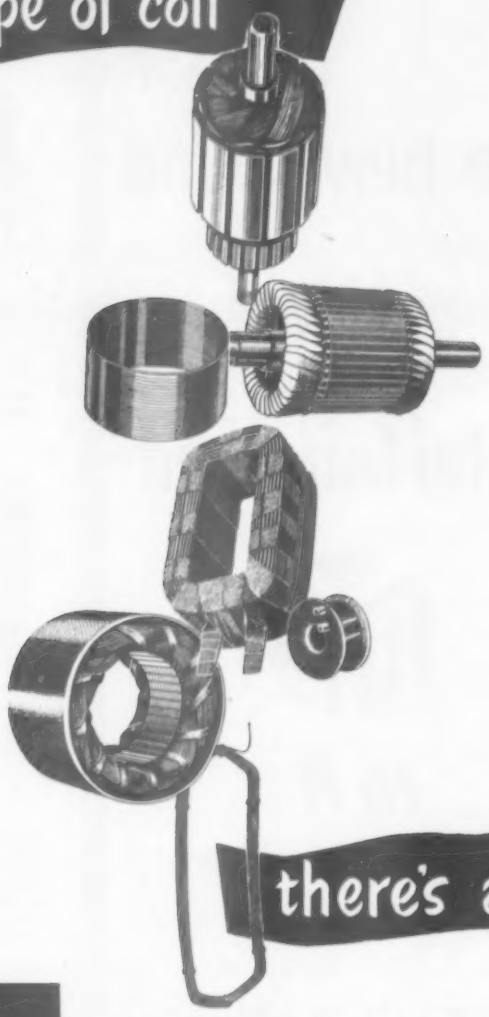

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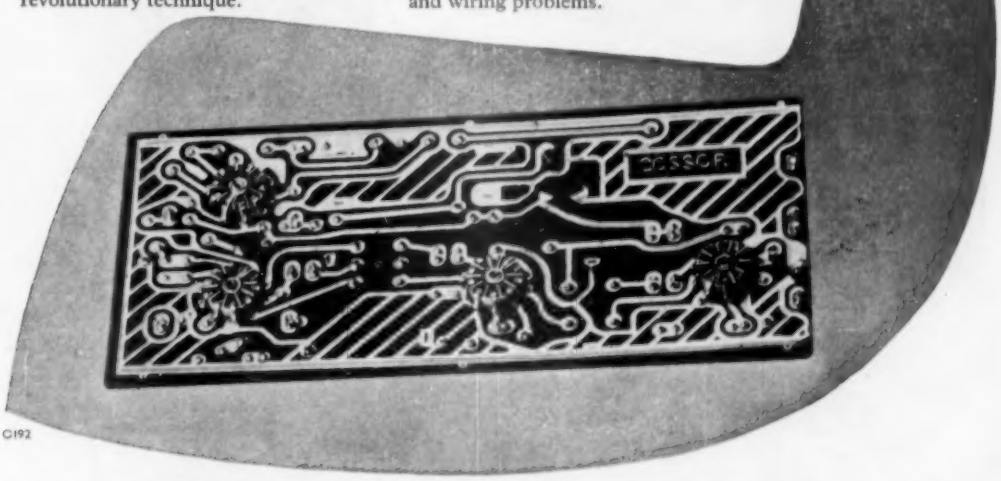

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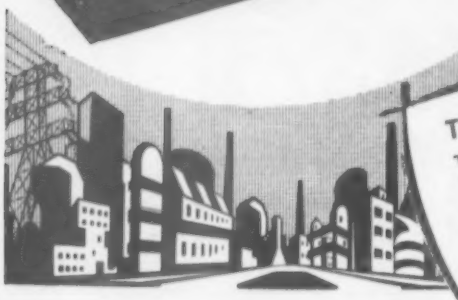

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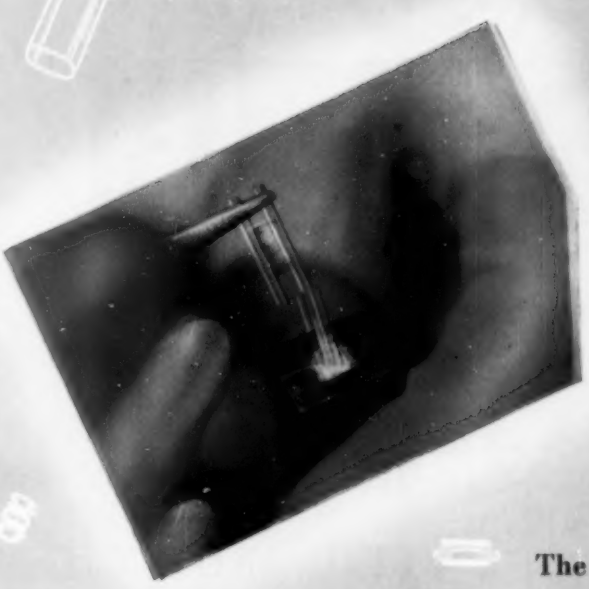

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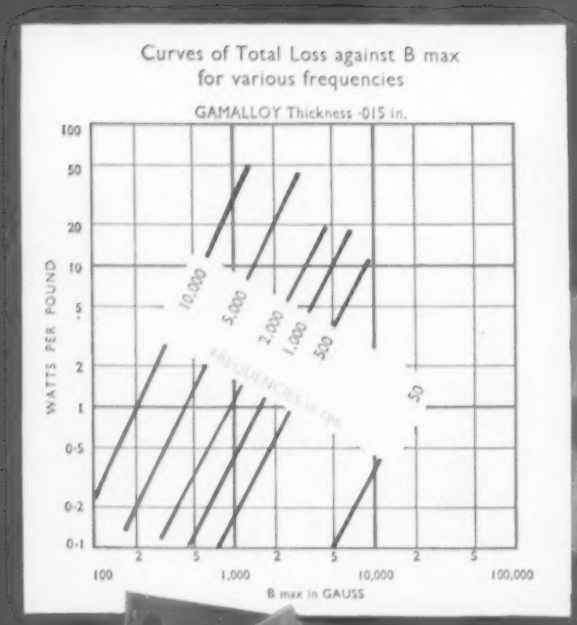

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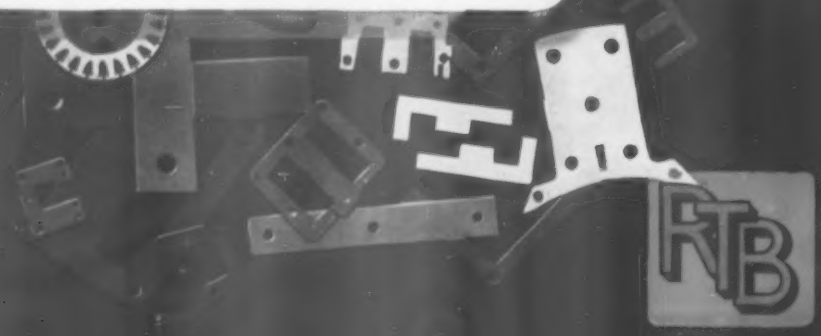

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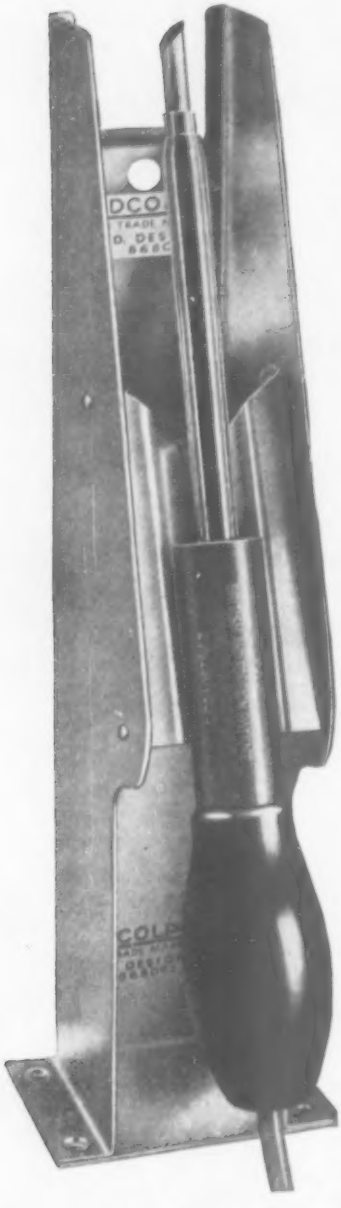

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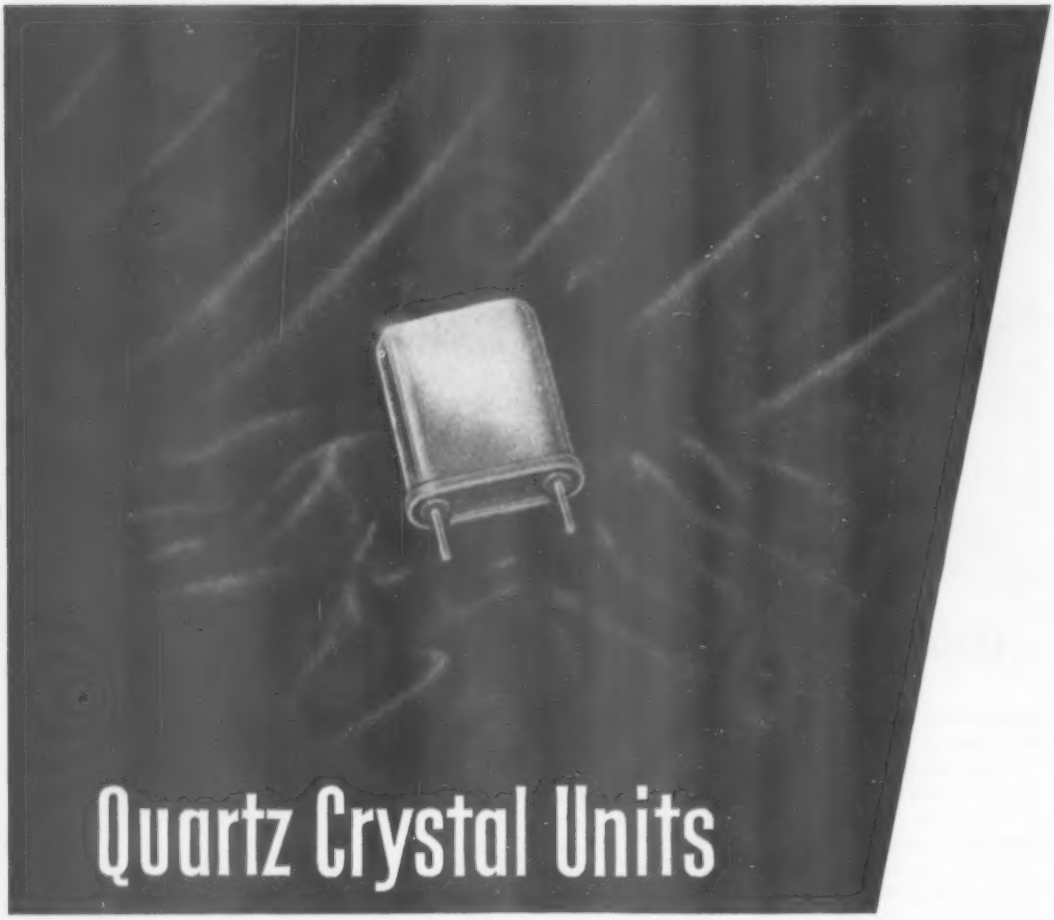

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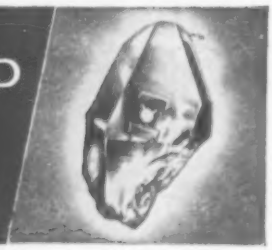

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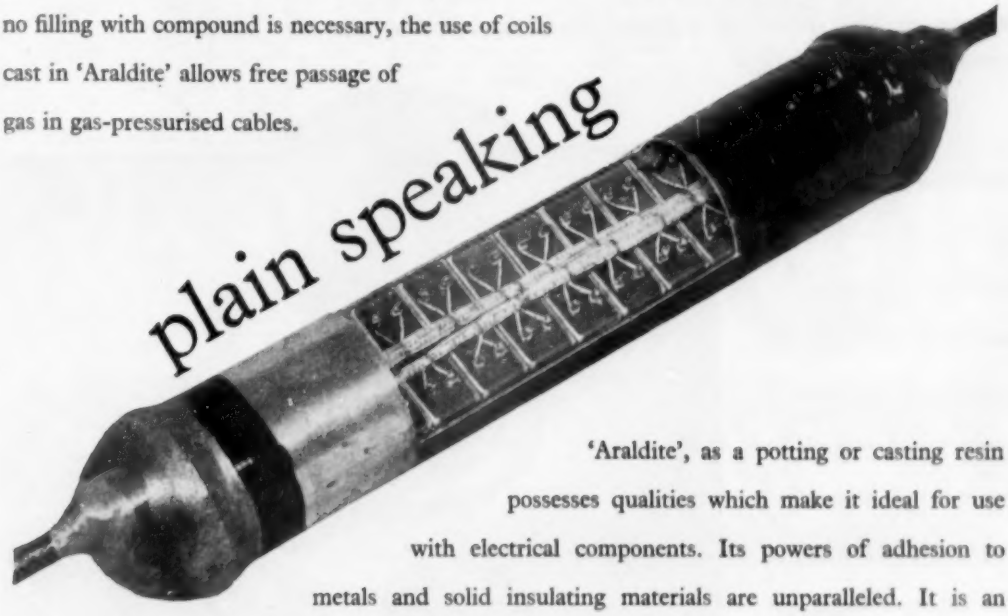

'Araldite', as a potting or casting resin possesses qualities which make it ideal for use with electrical components. Its powers of adhesion to metals and solid insulating materials are unparalleled. It is an excellent insulator, tough, flexible, highly resistant to 'tracking' and has a low power factor. It does not cause corrosion, provides complete protection against tropical conditions and complies with service requirements relating to sealing of components.

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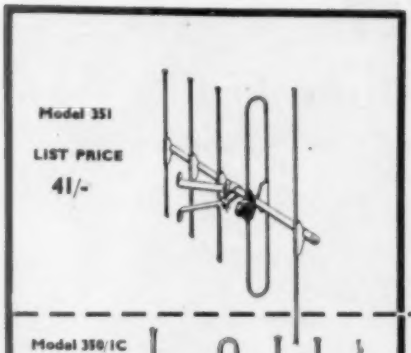
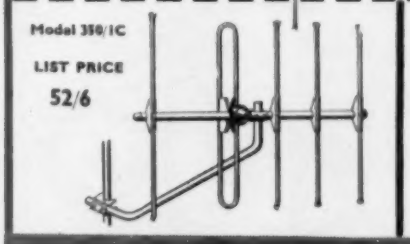


The Loft mounting models 331 and 351 are equipped with a special bracket for easy mounting in the loft and have sealed connections to enable them to be fitted to the window frame if required.

The exclusive "U" series of fully assembled Indoor Aerials have telescopic rods and rotatable adjustment to provide pinpoint reception on any Band 3 channel.

LOFT AND ROOM



3 and 5 element arrays—which have proved to be the most popular aerials for Band 3 reception in the London area—are available with three alternative mounting arrangements. Models incorporating a "U" Bolt Clamp for attachment to existing masts, as illustrated, have been outstandingly successful.

3 and 5

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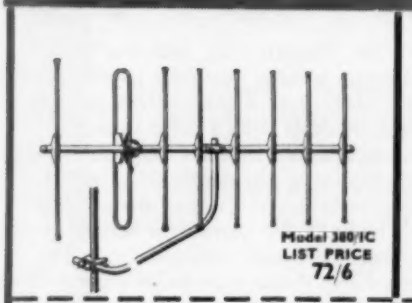
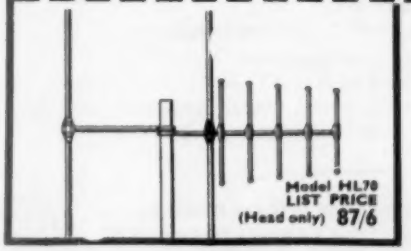


For areas where greater signal strength counts, the Antiference range contains 8 and 10 element arrays with a variety of mounting arrangements. All the exclusive Antiference design features are incorporated.

8 and 10



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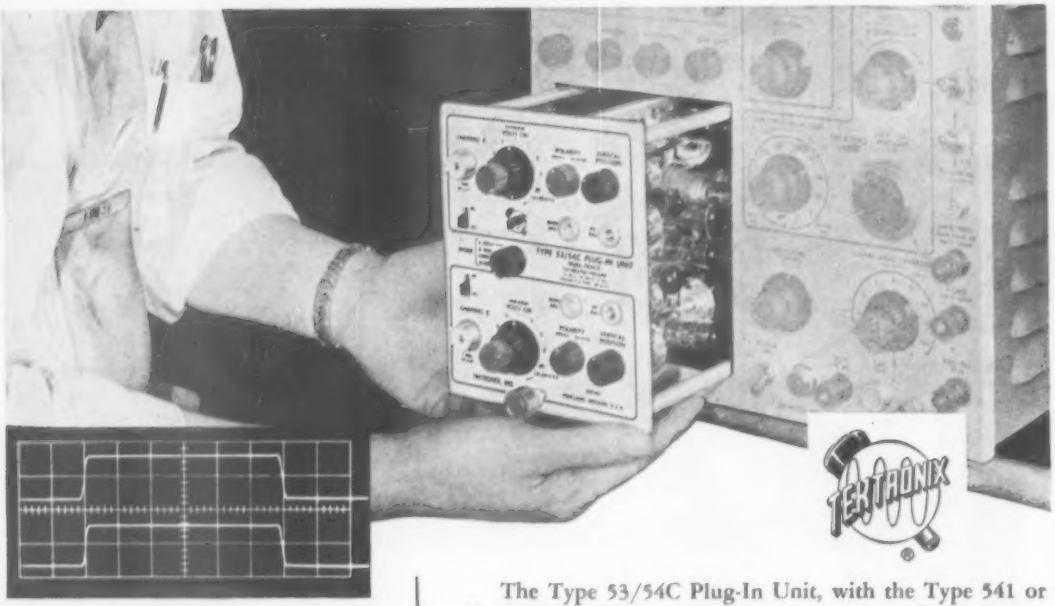
For Wide-Band Dual-Trace Applications

...with Tektronix Type 541 and Type 545 Oscilloscopes



Response of both channels to the same signal. A 0.6-μsec pulse is displayed on alternate 0.1-μsec/cm sweeps of the Type 545 Oscilloscope with the Type 53/54C Plug-In Unit.

Type 53/54C Plug-In Unit Characteristics

VERTICAL RESPONSE

With Type 541 and Type 545 Oscilloscopes
Passband—dc to 24 mc
(3 db ± ½ db down at 24 mc)
Risetime—0.015 μsec

With Type 531 and Type 535 Oscilloscopes
Passband—dc to 10 mc
Risetime—0.035 μsec

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20 μμf direct, 8 μμf with 10x probe (P410)—as little as 2.5 μμf with 50x accessory probe.

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Triggered—for alternate sweep presentations.
Free-running at about 100 kc—for single-shot presentations of two simultaneous transients.

***Price—$275 (106£)**

Prices F.O.B. Portland (Beaverton), Oregon
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The Type 53/54C is completely interchangeable among Tektronix Type 540-Series and Type 530-Series Oscilloscopes. When used with the Type 531 or Type 535 Oscilloscope it provides better overall passband and risetime characteristics (dc to 10 mc, 0.035 μsec) than its predecessor, the Type 53C.

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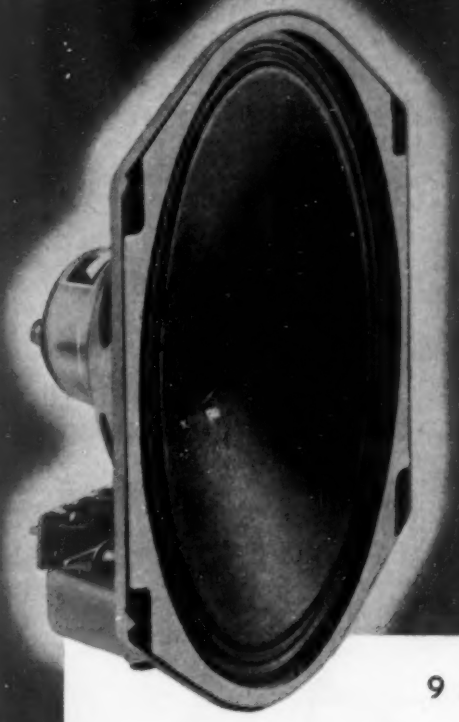

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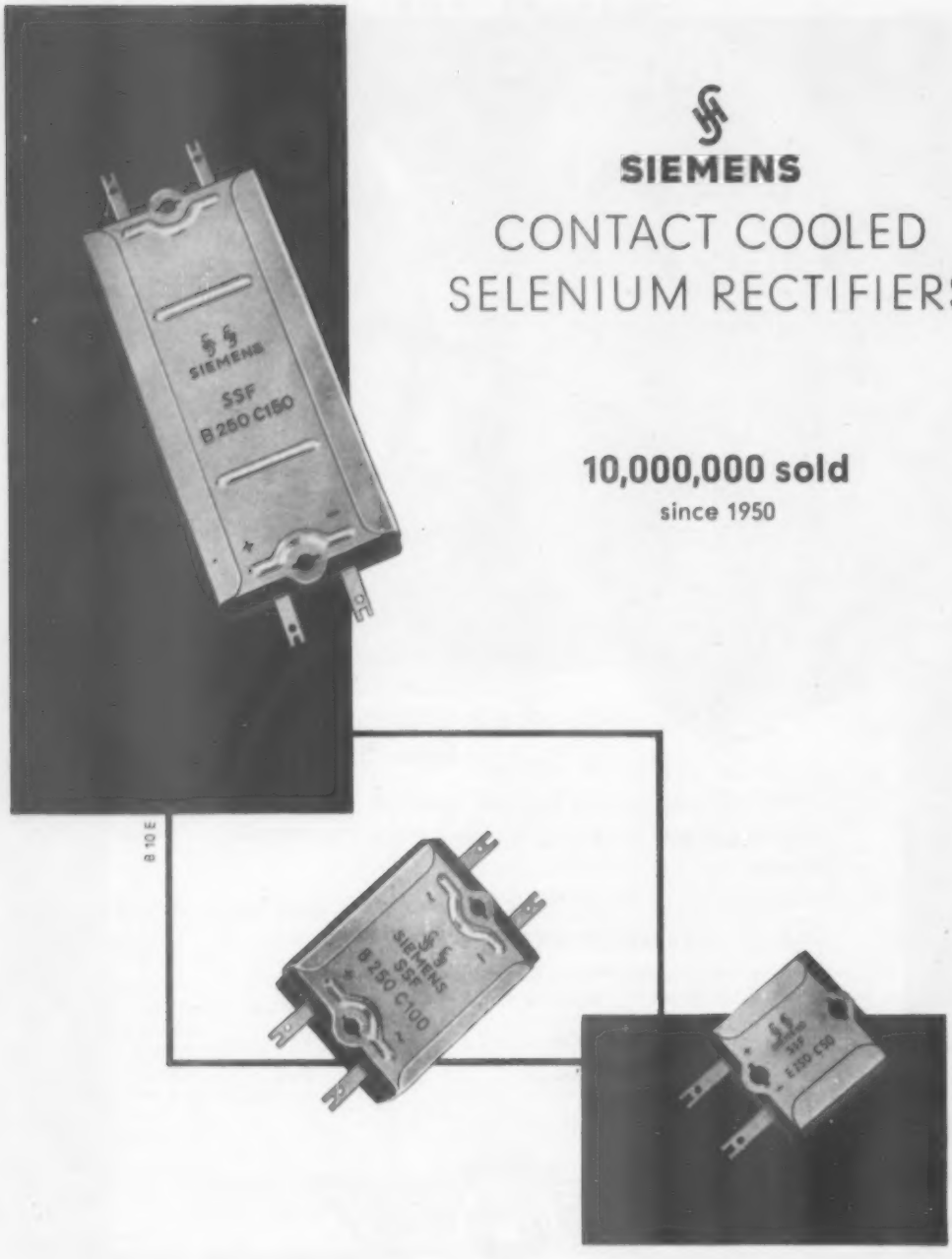

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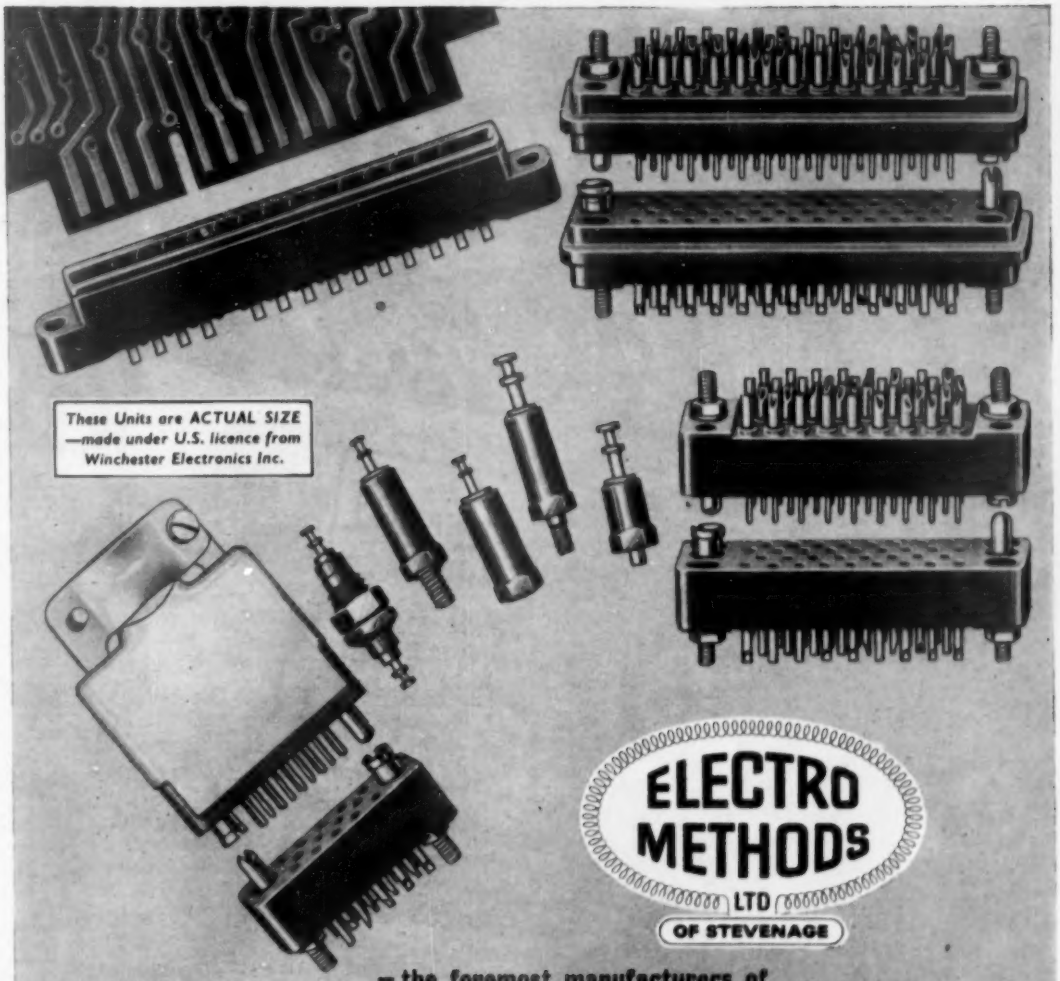

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SV-VR90/30	40
SV-VR75/30	40
SV-OA2	30
SV-OB2	30
G120/1B	30
G400/1K	4
G400/2G	4
G50/1G	0·5

MAINTAINING VOLTAGE (V)

VALVE CODE	CATHODE CURRENT mA
G150/2D	30
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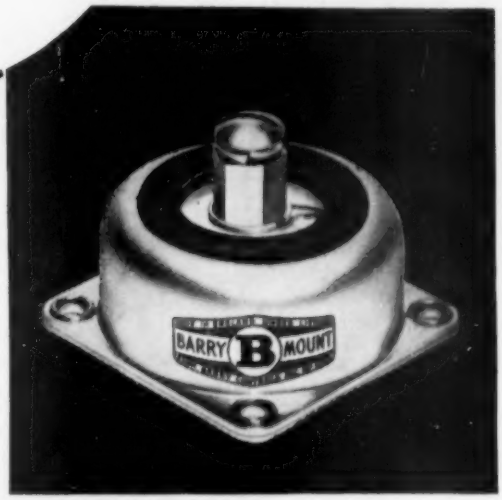

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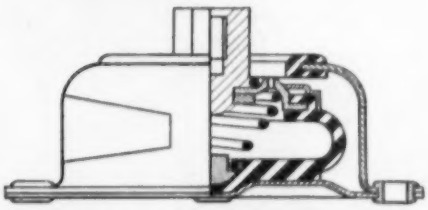

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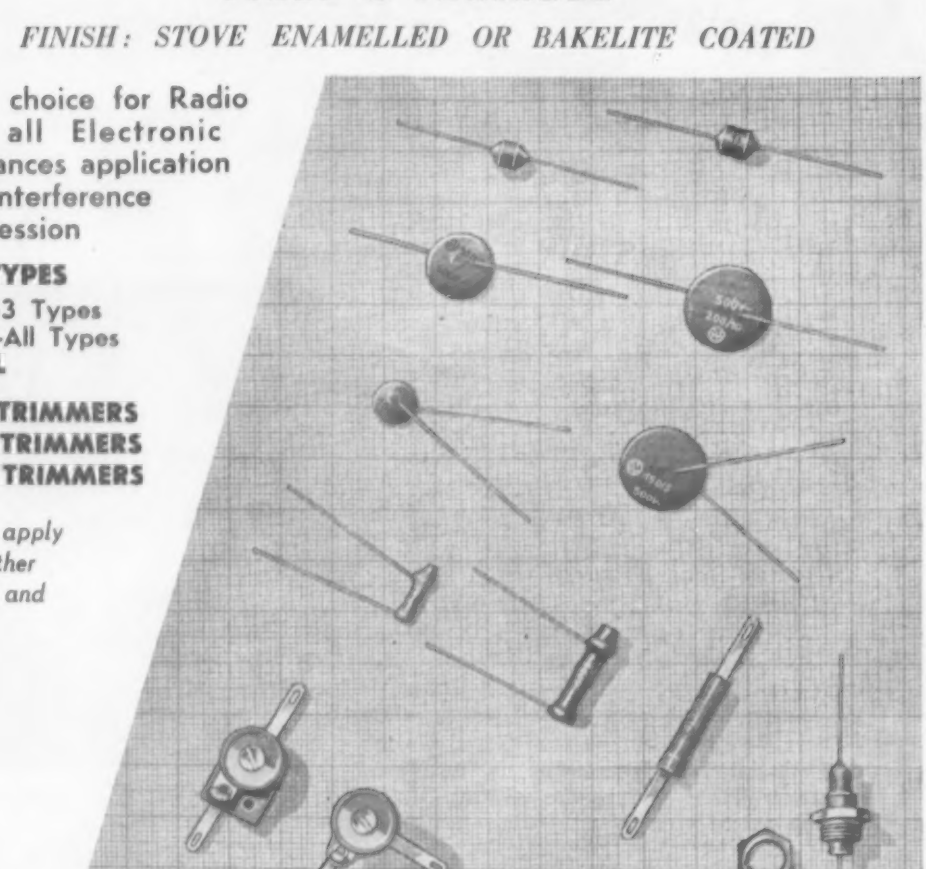

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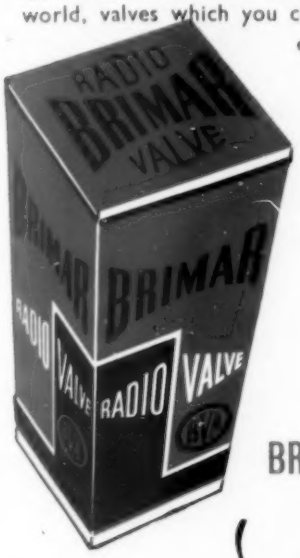

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B

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The GFT.560/2 is a 2-3 kW channelised transmitter with a frequency range of 1.5-30 Mc/s. It consists of three basic cabinets—r.f. unit, modulator unit, and power supply unit—combinations of which can be used to provide multi-frequency working as well as a number of different types of emission. The wave change facilities of the transmitter are both rapid and reliable—a valuable asset when the operating frequency is changed many times each day. The GFT.560/2 is fully tropicalised, and its unit construction facilitates future expansion of the initial installation, should the need arise.

For use in conjunction with the GFT.560/2 there are ancillary units that enable the transmitter to be remotely controlled over a two wire telephone circuit: operational adjustments are dialled to the transmitter.

The versatility and reliability of this new Mullard transmitter make it particularly suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. A team of Mullard communication engineers is available to advise on the use of the GFT.560/2 in such applications.

ABRIDGED DATA ***Frequency Range*** 1.5—30 Mc/s ***Frequency Stability*** To Atlantic City 1947 standards ***Power Output*** 3kW. c.w., 2kW m.c.w. or r/t ***Types of Emission*** c.w., m.c.w., telephony, frequency shift A.1, A2, A3, F1 ***Output Impedance*** 600 ohms balanced twin feeder ***Power Supply*** 400V. 50-60 c/s, 3-phase.

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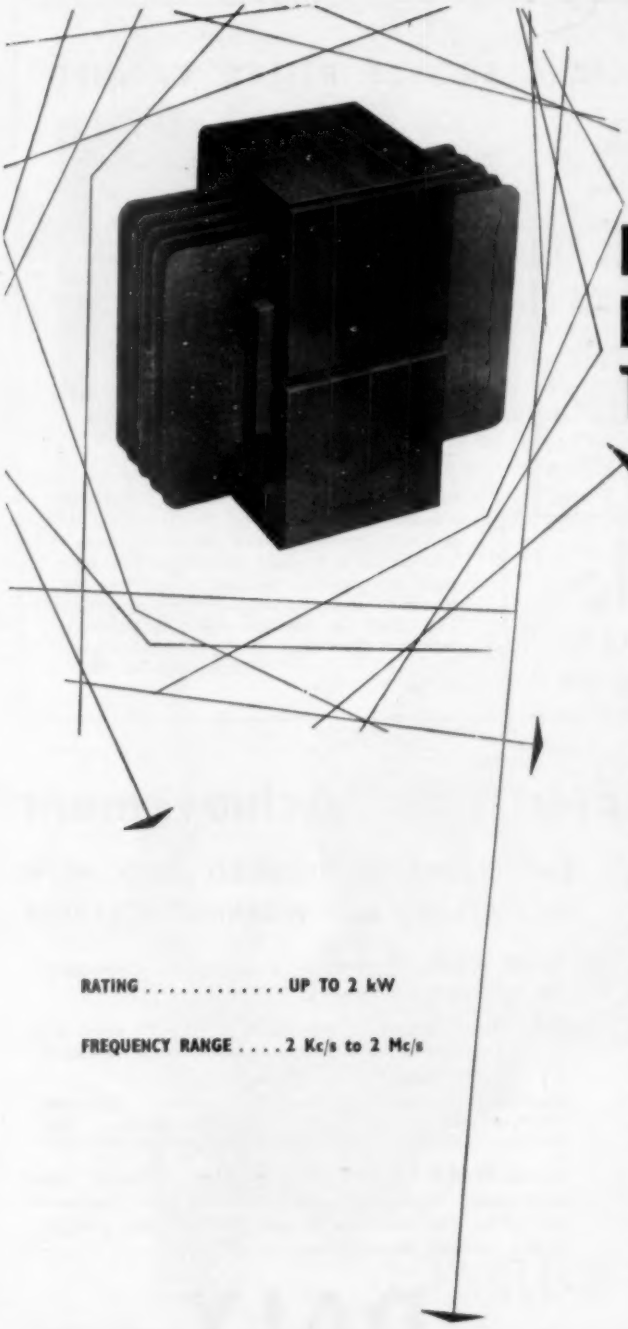

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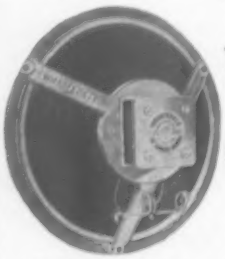

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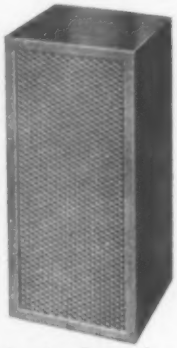

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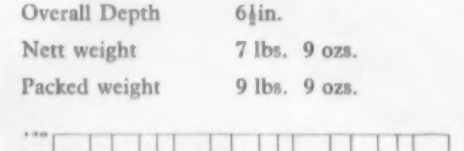

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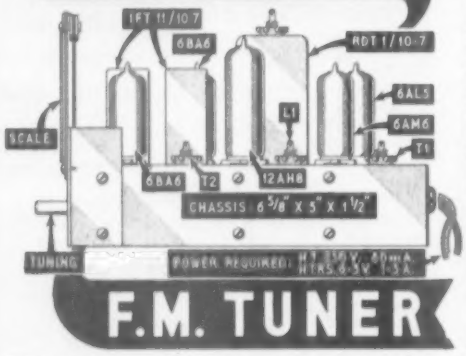

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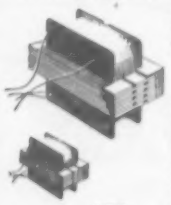

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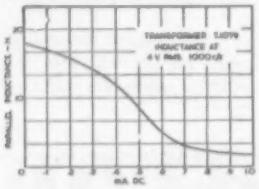

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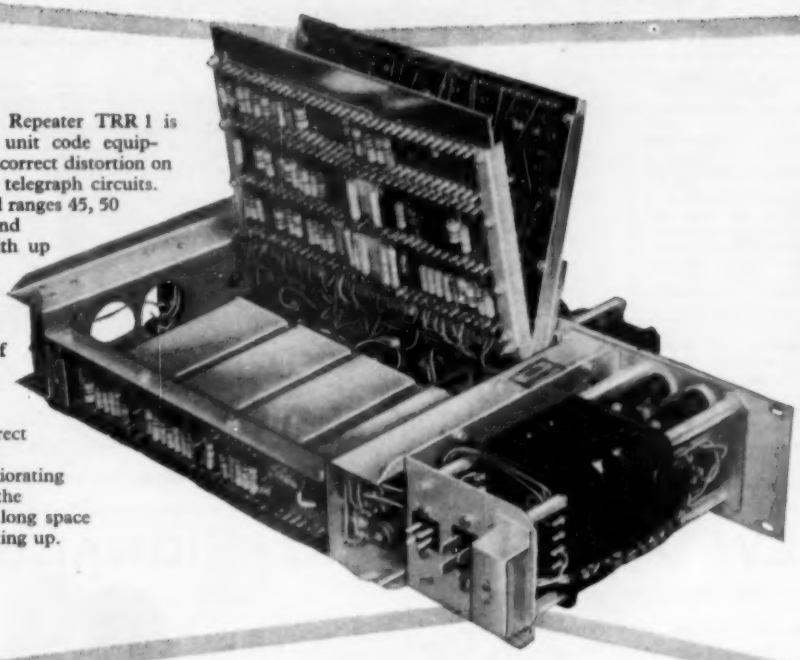

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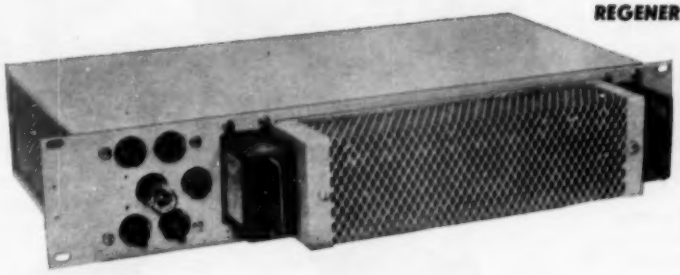

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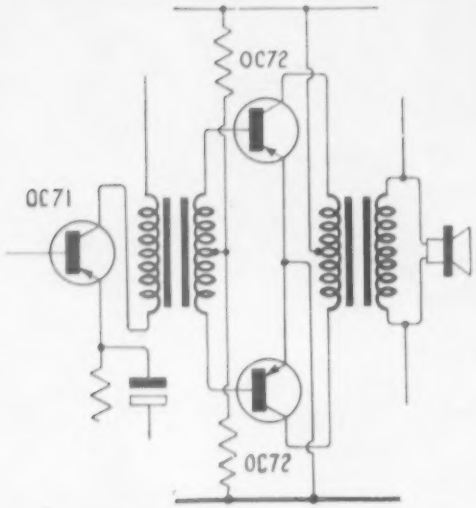

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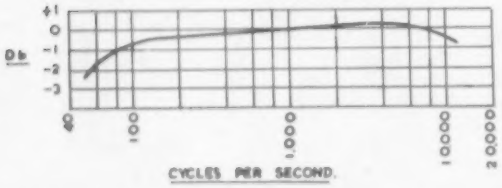

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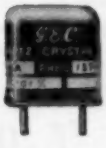

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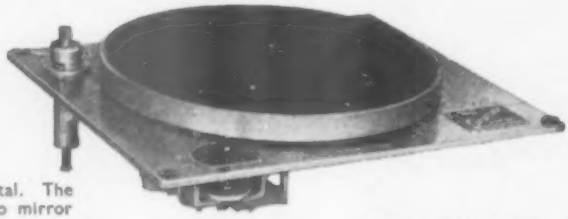

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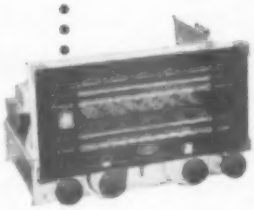

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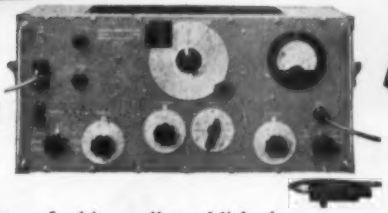

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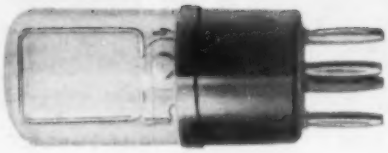

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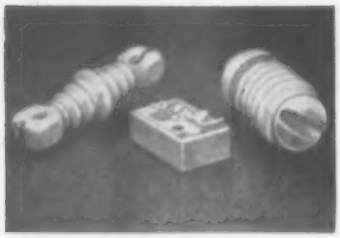

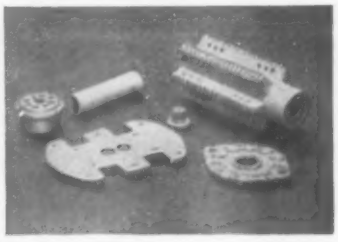

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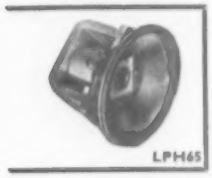

LPH65

The TSL LORENZ LPH 65 is the basic treble speaker used in the TSL LORENZ Sound System. Round in shape to ensure smooth, melodious sound the plastic cone is fully tropicalised. Special features are the super high flux density magnet of 17,500 gauss and non-perforated back plate.

SPECIFICATION LP312-2

IMPEDANCE 15 ohms; **FREQUENCY RANGE** 20-22,500 c/s; **POWER RATING** 25 w.; **PEAK POWER RATING** 40 w.; **DIAMETER** Bass 12½ inches, Treble 2½ inches; **DEPTH** Bass 7½ inches Treble 2 inches; **BAFFLE OPENING** 10½ inches; **SPEECH COIL DIAMETER** Bass 1.5 inches, Treble ½ inch; **FUNDAMENTAL RESONANCE** Bass 20 c/s., Treble 1,600 c/s.; **FLUX DENSITY** Bass 17,500 gauss, Treble 17,500 gauss; **INTERMODULATION PRODUCTS** under 0.5%; **CROSSOVER FREQUENCY** 2,000 c/s.; **FINISH:** Grey and blue vitreous anti-corrosion stove enamel.

RETAIL PRICE £14.19.6 (not subject to Purchase Tax).

SUPER HIGH FIDELITY THIS YEAR

Let your ears be your judge . . . crisp, clear, natural reproduction without coloration with TSL LORENZ speaker units. Ten years ahead in engineering and design, this speaker unit will enable you to design and build up a sound system in your own home which will truly add the miracle of LIFE to the magic of music . . .

No Extra Cost. You get these extra features at no extra cost with every TSL LORENZ Sound system . . . Greater output and more sensitivity . . . heavy duty oversize speech coil . . . Super high flux magnet . . . Permanently flexible self-damped cone . . . Multi-parameter cone fully tropicalised . . . Sealed in air gaps . . . built-in centralizing device for perfect gap alignment.

Improve your own H.F. Sound System. *For those devotees of high quality who possess bass speakers fitting one or more LPH65 treble units will greatly extend your range of super fidelity reproduction. They are, without a doubt, the most sensitive and efficient treble reproducers research has revealed to date. The non-perforated back plate ensures that the LPH65 can be used with any other speaker irrespective of make or type without interaction taking place.*

SPECIFICATION LPH65

HIGH FREQUENCY CONE-HORN TYPE TREBLE UNIT. IMPEDANCE 5.5 ohms; **FREQUENCY RANGE WITH SUITABLE HIGH PASS FILTER CONDENSER** 2,000, 22,500 c/s; **POWER RATING AS A SINGLE UNIT** 3 w.; **PEAK POWER RATING AS A SINGLE UNIT** 5 w.; **DIAMETER** 2½ inches; **DEPTH** 2 inches; **BAFFLE OPENING** 2½ inches.

PRICE 39/6. (including Purchase Tax).

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The physical confines and electrical parameters of modern electronic equipment makes unprecedented demands on the component manufacturer. His product must almost invariably be smaller than its predecessor and more efficient and durable. These potentiometers provide an outstanding example of what can be achieved to meet the present requirement.

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Moulded track potentiometers by Plessey possess a high standard of stability within a wide range of operational temperatures and can be stored for extended periods without deterioration. They can be manufactured to conform, within strictly specified limits, to a designed pattern of values at various positions on the track.

DURABLE

The outstanding reliability of these potentiometers is a tribute to the Plessey Research and Development engineers whose efforts to meet the stringent Services requirements and the critical demands of the Commercial market have resulted in products of superior design and function.

Miniature Type M H 2

A high quality potentiometer for commercial laboratory and Services application. Services Specification RCS122. The standard version is fitted with spindle and panel humidity seals.

GENERAL SPECIFICATION

Rating: ambient 70°C	¼ watt
Temperature Cat.	40/70°C
Humidity Class	H2
Minimum Resistance	50 ohms max.
Overall Diameter	23/32 in.
Overall depth of control from mounting face, including tags	⅝ in.

Sub Miniature Type G

Type Approved to Certificate No. 974 Issue 1, Ref. TA1373, this pre-set, open-type control is of particular interest to industrial communication and Service equipment manufacturers.

GENERAL SPECIFICATION

Range Linear ±20%	1,000 ohms to 2 megohms
Rating: ambient 70°C	¼ watt total track rating
Minimum Resistance	50 ohms max.

Spindle and Panel Sealed Type E H 2

For military and para-military applications, this control is particularly resistant to conditions of extreme humidity.
Type Approved to Certificate No. 906, Issue 2, Ref. TA1230.

GENERAL SPECIFICATON

Rating: ambient 100°C	1 watt
Temperature Cat.	40/100°C
Voltage Limitation	500V
Humidity Class	H2
Minimum Resistance	50 ohms max.
Overall Diameter	1-5/32 in.
Overall depth of control from mounting face	21/32 in.

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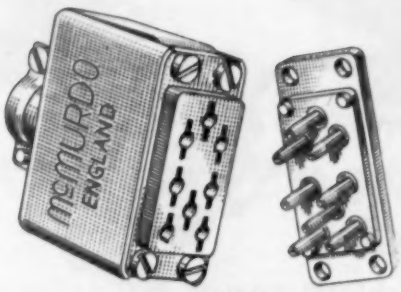
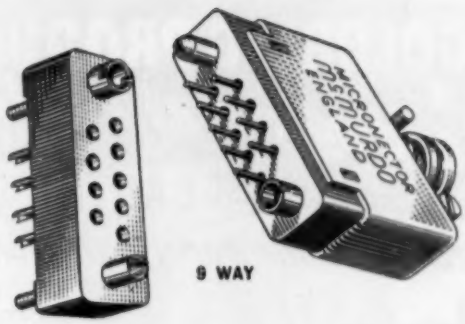


8 WAY



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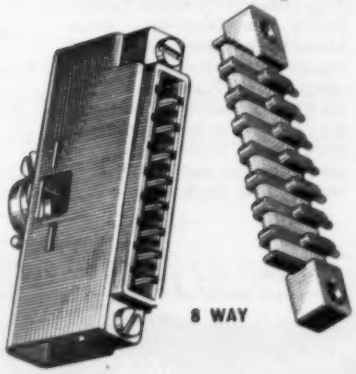

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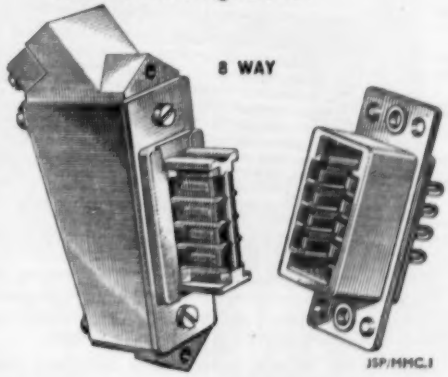

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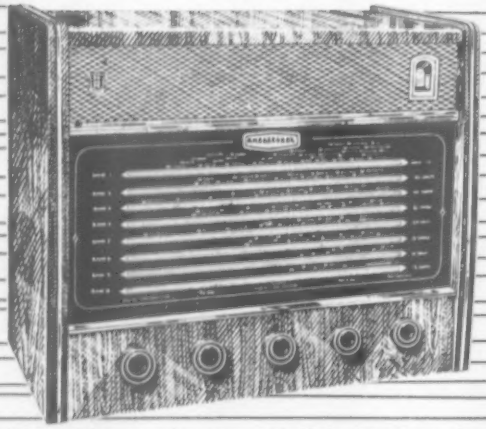

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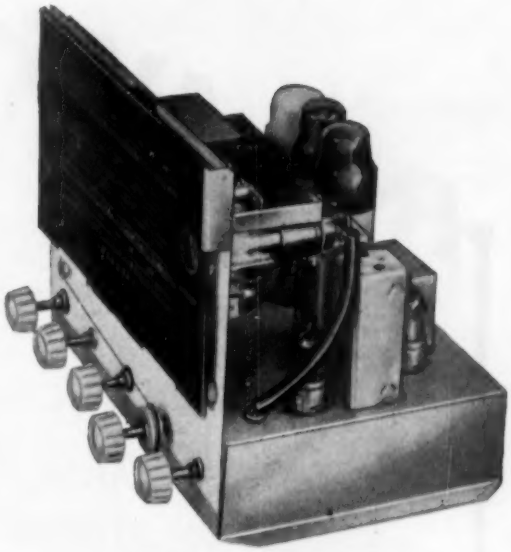

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Precision flywheel tuning with slide rule accuracy.

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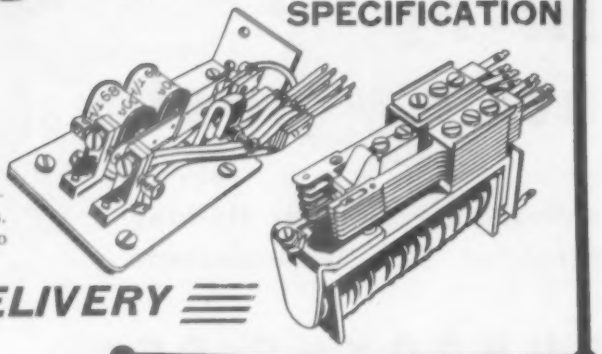

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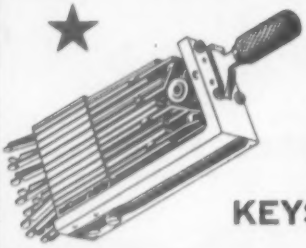

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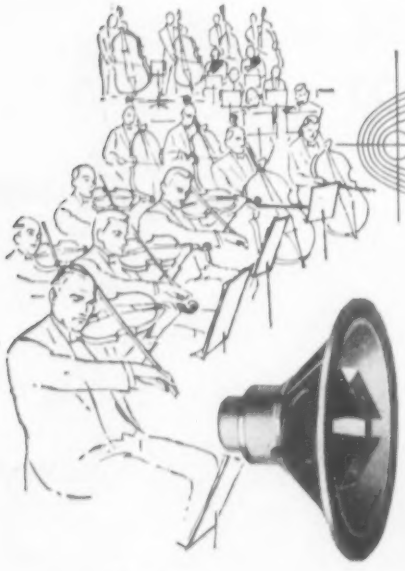

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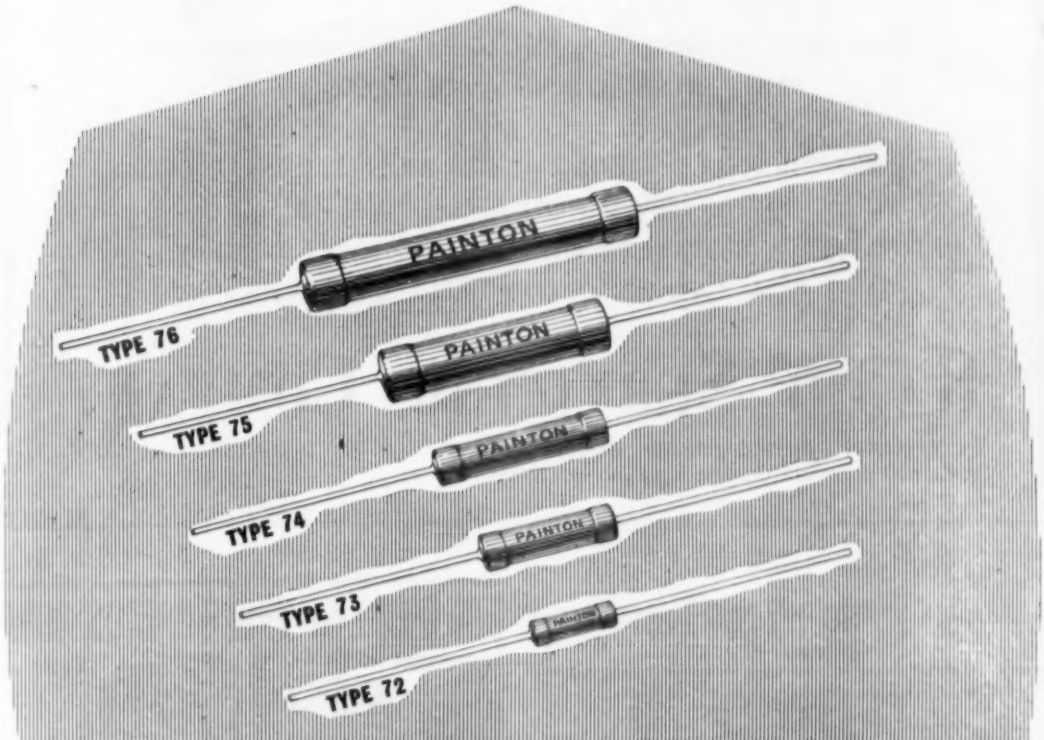

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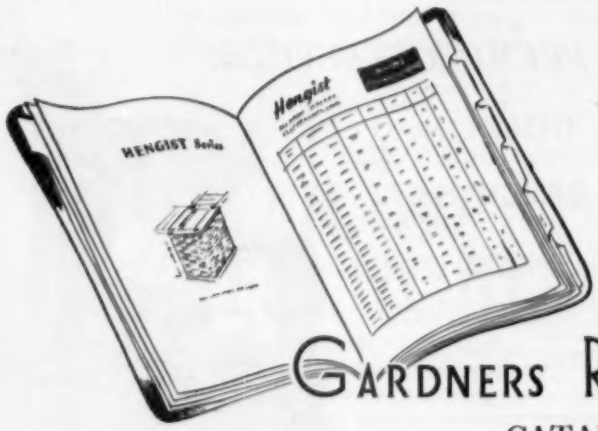

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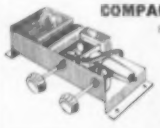

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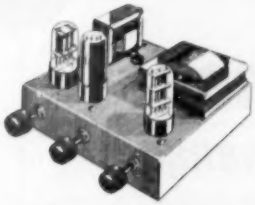

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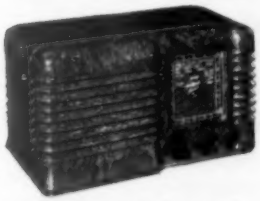

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Wireless World

ELECTRONICS, RADIO, TELEVISION

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JULY 1956

In This Issue

Editorial Comment		303
Dip Soldering	*H. G. Manfield*	304
Television Pattern Eliminator		307
World of Wireless		308
Crystal-Controlled F.M. Receiver	*D. N. Corfield*	312
Selective "Paging" System		316
Semi-Conductors	*"Cathode Ray"*	317
Letters to the Editor		322
Ferroresonant Computing Circuits	*R. S. Arbon and G. Phylip-Jones*	324
Two-Channel Stereophonic Sound Systems	*F. H. Brittain and D. M. Leakey*	331
Developments in Sound Reproduction		335
Short-wave Conditions		339
F.M. Tuning Meter	*R. S. Ferguson*	340
Wafer Cells	*R. W. Hallows*	341
"Precipitation Static"		343
Simple Telephone Answering Machine	*H. G. M. Spratt*	344
Book Received		346
European V.H.F. Broadcasting	*G. H. Russell*	347
Electron Tube Information Service		349
Random Radiations	*"Diallist"*	350
Unbiased	*"Free Grid"*	352

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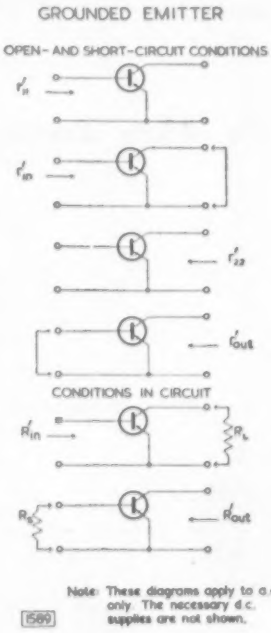
Transistors under Small Signal A.F. Conditions

Many types of equivalent circuit have been put forward in trying to replace the empirical methods of designing transistor circuits by a system of mathematical calculations. If the attempt is made to represent transistor performance completely in this way, the transistor appears as a complex device with, among other things, a frequency-dependent phase relationship between input and output, and the proposed equivalent circuits become correspondingly complicated. When, for example, the circuit is to represent the transistor at frequencies comparable with the cut-off frequency at which (by definition) the current amplification factor a is 3dB below its low frequency value, it may be necessary to include delay lines or similar devices.

Fortunately the calculation of the performance of junction transistors at audio frequencies and for small signals can be very much simplified. The system described here treats the transistor as a four-terminal 'black box' from which are derived five characteristics or 'parameters'. For grounded base operation they are: (1) current gain a with output short-circuited to a.c.; (2) input resistance r_{11} with the output open-circuited to a.c.; (3) input resistance r_{in} with the output short-circuited to a.c.; (4) output resistance r_{22} with the input open-circuited to a.c.; (5) output resistance r_{out} with the input short-circuited to a.c. Similar quantities are defined for grounded emitter operation, and are primed to distinguish them, thus a', r'_{11} etc. (See figure).

These parameters show immediately the limits of the input resistance and output resistance of the transistor. Thus for a typical OC71 in grounded emitter operation with a working point $V_c = -2V$, $I_e = -3mA$, the input resistance lies between $r'_{in} = 800\Omega$ ($R_L = 0$) and $r'_{11} = 500\Omega$ ($R_L = \infty$); similarly the output resistance lies between $r'_{out} = 21k\Omega$ ($R_s = 0$) and $r'_{22} = 13k\Omega$ ($R_s = \infty$). In practice either $R_L = 0$ or $R_L = \infty$ means that the load resistance is very small or very large compared with the output resistance of the transistor. Also $R_s = 0$ implies a.c. drive from a voltage source, and $R_s = \infty$ a current source.

The parameters give convenient and comparatively simple expressions for the current, voltage, and power gain of the transistor in circuit, and for the circuit input resistance R_{in} and output resistance R_{out}. The formulas for grounded base and grounded emitter operation are identical in form, but for grounded emitter circuits the calculations must always be made with the dashed or primed quantities a' etc., and of course the results are numerically different. All the formulas consist of a simple fixed term (dependent on the transistor only) multiplied by a term which varies in a fairly simple manner with the circuit values.



Note: These diagrams apply to a.c. only. The necessary d.c. supplies are not shown.

589

The table shows the conversion from the T-network system of r_e, r_b, r_c and r_m to this Mullard system of parameters, and also gives the relationship between grounded emitter and grounded base characteristics in the Mullard system. It can be seen that with grounded base r_{11} and r_{22} are independent of a, and r_{in} and r_{out} decrease with increasing a. For grounded emitter, r'_{11} is independent of a'; r'_{22} decreases almost proportionately with increasing a'; r'_{in} increases with a'; and r'_{out} decreases with increasing a'.

Grounded Base Characteristics	Grounded Emitter Charact.	Conversion	Equalities
$a = \frac{r_m}{r_c}$	$a' = \frac{r_m}{r_c - r_m}$	$a' = \frac{a}{1-a}$	$\frac{r_{in}}{r_{11}} = \frac{r_{out}}{r_{22}}$
$r_{11} = r_e + r_b$	$r'_{11} = r_e + r_b$	$r'_{11} = r_{11}$	
$r_{in} = r_e + (1-a)\, r_b$	$r'_{in} = r_b + r_e(1+a')$	$r'_{in} = r_{in}(1+a')$	$\frac{r'_{in}}{r'_{11}} = \frac{r'_{out}}{r'_{22}}$
$r_{22} = r_c$	$r'_{22} = \frac{r_c}{1+a'}$	$r'_{22} = \frac{r_{22}}{1+a'}$	
$r_{out} = r_c\left[1 - \frac{ar_b}{r_e+r_b}\right]$	$r'_{out} = \frac{r_c}{1+a'}\left[1 + \frac{a'r_e}{r_e+r_b}\right]$	$r'_{out} = r_{out}$	$a'r'_{22} = ar_{22}$

Reprints of this advertisement will not be available

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MVM 358

Wireless World

JULY
1956
Vol. 62 No. 7

Television Puzzles

SEVERAL diverse views on the choice of television systems for the future have been expressed during recent months by correspondents and contributors to our pages. Naturally enough, most of the proposals have been made with the underlying idea that, sooner or later, transmissions in colour will come. Over some of the factors involved, both technical and economic, there is quite a violent clash of opinion. At the present stage, all that *Wireless World* can do is to ensure fair play for the contestants, without making any attempt to give a verdict. Perhaps, though, it would be helpful briefly to review the situation as it stands.

One school of thought, of which Sir Robert Renwick is a leading spokesman, has urged that colour transmissions in this country should be based on the continental 625-line system. The main argument in favour of this is that, thanks to a large domestic production, Britain would then be in a favourable position to export receivers both to the Continent and to other countries adopting the same standards. Another point is that the international exchange of programmes would be made easier. At present, we are the "odd man out."

In a letter printed elsewhere in this issue Sir Robert reaffirms his views, clearly disagreeing with the *Wireless World* opinion that there is unlikely anyway to be a rich export market in receivers. (Our argument was that any country sufficiently developed industrially to have any kind of a television service would probably make its own receivers.)

Another published letter from W. Jones, general manager of Pye Canada, after expressing qualified agreement with that argument, goes on to make the valuable suggestion that the British manufacturers should concentrate on the dollar market by exporting television receiver sub-assemblies. However, Mr. Jones believes that these sub-assemblies could not be exported at economic prices unless backed by production, presumably of identical articles, for domestic consumption. To us, that rather spoils the picture: it is a fact that very few sub-assemblies are interchangeable between receivers for North American use and those for the British 405-line system—or, for that matter, for the continental 625-line standards. It could hardly be seriously suggested that we should change over to the American standards solely in the interests of export trade, vital though it may be to this country. To carry such a suggestion to its logical conclusion, we should use in Britain *all* the systems of those countries to which we might conceivably export with profit! Are we right in thinking that all this lends support to our original contention?

On the more technical side, the 625-line system to which we are asked to change has found singularly few champions. V. J. Cooper, who, in the April issue, examined the system in the light of future adaptation to colour, concluded that it offers no attractions in comparison with the existing British standards. Others have gone even farther in stigmatizing the 625-line system as an unbalanced one (with unequal vertical and horizontal definition) which fails to make the best use of the very considerable bandwidth required. Any change we may make will have to endure long into the future; what we choose *must* be good.

Ideas on the future of television were further complicated when, in our May issue, Dr. D. A. Bell entered a strong plea for higher definition *instead* of colour. On this question we feel the voice of the customer—the television producer—should be heard before spending time on a close examination of the technical implications. Which does the producer want most? Indirect, and probably unconscious, support for Dr. Bell's views has since come from the cinema industry, which, according to report, is considering reversion to black-and-white photography for a number of films on grounds of economy. This is a sobering thought; if the cinema cannot afford colour, can we afford it for television, where the costs will be, so far as can be foreseen, much higher.

What is Automation?

TO use words without knowing their meaning is more worthy of parrots than men, so we ought to have a precise definition of the witch-word "automation", which will doubtless come into wider use in our field. Does automation essentially involve feedback, more or less in our sense of the word? Apparently not. After studying the literature, we are left with the feeling that it means "the mixture as before, but rather more so."

DIP SOLDERING

By H. G. MANFIELD*

A Method for Use with Printed Circuits

A method of dip soldering components on to a printed circuit pattern is described in detail in this article. The circuit is printed on one side of an insulating board and the components are assembled on the reverse side.

Cleaning, fluxing and soldering are shown to be an integrated process which, when handled mechanically, produces perfect soldered joints between the wiring and the components. The method is simple and requires no elaborate equipment.

ALTHOUGH it has been known for some time that printed wiring circuits have been dip soldered in both this country and in the U.S.A., no published accounts have been given of the detailed processes involved. This article describes a process which has been evolved at the Radar Research Establishment, Malvern.

Requirements.—At present a large percentage of the labour in the electronics industry is devoted to making soldered connections by hand. When this is done correctly, with adequate inspection, the results are very satisfactory, but there is a risk that an operator will miss a joint or will omit to flux or clean it; the result is then a dry joint which is difficult to discover. Modern cored solders have largely eliminated the dry joint but the risk remains.

The great appeal in the use of the printed circuit is that by eliminating plastic-covered wires and by laying out the pattern in two dimensions, it becomes possible to dip the entire unit in a solder bath and make all the joints in one operation. Unfortunately, the operation is not so simple as it seems and unless it is properly carried out the results are apt to be disappointing.

It must be possible to make joints between the wiring and the components in such a way that there are no dry joints and the components—many of which are heat-sensitive—are not damaged. The requirements for a dip soldering system may be stated as follows:

1. It must produce perfect joints.
2. It must allow of the use of standard components without damaging them.
3. It must not damage the plastic base material on which the circuit is printed.
4. Highly activated or corrosive fluxes may not be used.
5. Special soldering alloys and solders of special purity should not be needed because of the difficulty of maintaining purity.
6. Any flux or other surface treatment must not lower the insulating properties of the base material.
7. It should be possible to adapt it to small-scale production.

Some of these requirements might be relaxed for use with domestic apparatus, and tooling costs would be of less importance with large-scale production, but the scheme to be outlined has been designed against a background of these requirements.

The Printed Wiring.—The base material on which the circuit is to be printed may be of practically any plastic, but in practice it is nearly always a laminate of some kind. Paper laminates impregnated with phenolic resins are commercially available in many different grades. Copper foil, usually 0.0015in thick, may be bonded either to one or to both sides. Laminates of glass-fibre cloth with silicone, epoxy or polyester impregnation are also freely available and can be used where the electrical or mechanical properties of paper laminates are inadequate.

Paper laminates vary in quality. There are so-called punching grades where the proportion of paper to resin is higher than in the electrical grades. Each type presents its own problem from the point of view of dip soldering. The laminate with high resin content may have some by-product of the condensation reaction trapped beneath the copper foil. If this is so, then on heating there is a sudden expansion of the gases and a blister is formed under the metal surface; in some cases this blister explodes and ruptures the metal foil. With the low resin content material, the predominance of paper leads to a higher rate of water absorption than with the higher-quality type, and the material, on heating, expands with a similar result to that already discussed.

The choice of a suitable base is therefore somewhat complicated by the diverse requirements. In all cases it has been found essential to dry out the materials before use, but as this is also a prior requirement of any electrical material, it should be part of a standard treatment.

The pattern is printed by one of many different processes—by silk-screen, litho-offset or by photo-mechanical means. The process to be described

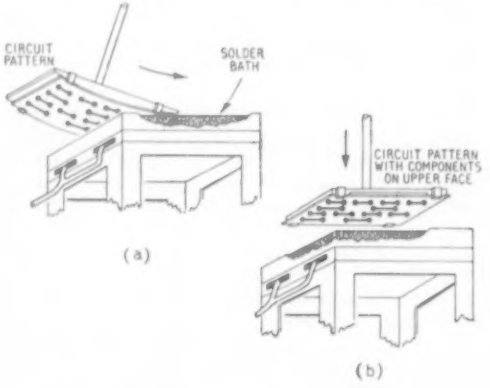


Fig. 1. Diagrammatic sketches showing (a) the preliminary tinning and (b) the soldering process. For the tinning process the board is bent to a shallow arc.

* Radar Research Establishment.

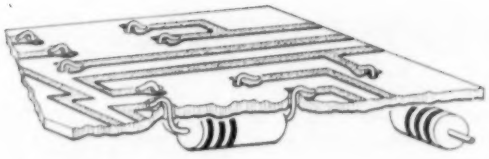


Fig. 2. Typical joints and terminations on a printed circuit board before soldering.

uses the last-named means of printing which is done by the so-called double-layer method. It is not necessary to go into the details of this method here as it has been described in great detail[1]. Suffice it to say that the copper-clad laminate is coated first with a cellulose lacquer and then with a sensitized coating which is exposed to ultra-violet light through the photographic negative. The image is developed, leaving the required pattern in acid-resisting lacquer. After etching in ferric chloride the circuit pattern is ready for the first treatment towards the dip-soldering process.

Preparation for Soldering.—It is always necessary thoroughly to clean the surface of the copper before any printing process is commenced. In the double layer process, the lacquer protects the copper through the etching stage right up to stacking and preparation for dipping. At the appropriate time, the lacquer is removed with a solvent—usually acetone—and sprayed with an activated liquid flux. In some cases the holes for component insertion are either drilled or punched, but this may be done after the first-stage tinning process; this will be discussed in detail later.

First Stage: Tinning Process.—When two surfaces to be joined are clean and well tinned the subsequent soldering operation is very simple. The case of the flat printed circuit is no exception to this rule, but chemical tinning and electroplating are useless because oxides are formed on the faces which resist the solder to such a degree that soldering becomes impossible. It is a common experience that it is quite impossible to solder to electroplated soldering tags until the tin is removed.

The circuit pattern after removal of the lacquer and coating with liquid flux is drawn over the surface of the solder bath at the rate of about an inch every five seconds. It is thoroughly dried out and then preheated before entering this first bath. The pre-heating is very important as the top surface of the bath—the only part that matters during soldering—is rapidly chilled when it meets a large area of cold board. Hot air is blown on its surface to raise the temperature to about 100°C. The solder is of 60/40 tin/lead alloy at a temperature of 250°C (+0°, −2°). The choice of temperature has been subject to considerable experiment. If one were soldering metal canisters, then the higher the temperature (within reason) the better, but with plastic base materials which are sensitive to heat, 250°C is about as high as can be tolerated. To reduce the temperature still further would increase the surface tension and decrease the wetting properties of the solder and the extra time in the bath would probably cause more damage than would a shorter dip at a higher temperature.

The ratio of tin to lead is decided by how much time can be allowed for the joint to solidify before it is moved. With a eutectic alloy there is a sudden transition from the liquid to the solid state but, in order to rely on this feature, it is essential carefully to control the purity of the bath and this is very difficult to do economically.

It has been found impossible to draw the board across the solder bath by hand, and a simple mechanism has been made to swing it over the surface of the molten solder. The mechanism is driven by an electric motor, and thus a smooth and steady passage across the bath is ensured, allowing about half the depth of the board to pass through the solder. The method is shown diagrammatically in Fig. 1(a).

When done as described, the entire surface of the wiring pattern is covered with a thin layer of solder without the build-up of "stalactites." If these are formed, it is because the surface of the copper is not at soldering temperature: it must be remembered that solder solidifies at 183°C and if the temperature falls to this while the circuit is being withdrawn from the bath, the coating will be drawn up in the form of "stalactites."

Second Stage: Soldering Process.—If the holes have not already been punched or drilled they can be made now. The type and size of hole will, of course, vary with the terminations of the component to be inserted; owing to the lack of standardization of terminations, it is not generally possible to have the hole of such a size that the component is fitted tightly to the board by virtue of being pushed through a hole.

A type of construction that is finding favour involves inserting the component wires and turning them over on to the wiring. There is thus a greater area of contact and the component is securely held before dip soldering. This method of assembly is also carried out by a type of automatic component insertion machine that is being developed both in America and the United Kingdom. In this construction it is not essential to punch or drill through the wiring pattern; this can be done just before the end of a printed wire, thus avoiding any tendency to strip the copper foil; it also avoids any difficulty that may be caused by the somewhat uneven surface of the tinned circuit. Typical joints and terminations of this novel type are shown in Fig. 2.

With the components inserted and the wiring bent over, it is necessary to degrease both the wiring pattern and the terminations. This is done by dipping the board, circuit pattern downwards, into a degreasing solvent—trichlorethylene has been found very satisfactory for this purpose. Care must be taken with this operation or the paint on the components will be removed, thus making them difficult to identify.

The circuit pattern and the component leads are sprayed or brushed with the same flux as before. After thorough drying, the whole assembly is lowered into the solder bath slowly. It is first preheated as before, but this is not quite so important at this point because the entire area will enter the bath and stay there long enough to reach soldering temperature. The mechanism which was used to tin the surface also controls the movement of the board into and out of the bath, the time in the bath being between three and five seconds. Fig. 1(b) shows the method diagrammatically.

On removal, the entire circuit is seen to be connected up; each joint is not only perfect electrically

[1] Manfield, H. G., "Etched Foil Printed Circuits", *Wireless World*, September, 1955.

but also looks perfect physically. The wiring pattern builds up into a hemispherical surface and the connections to the components are covered with a layer of solder, smooth and without spikes.

Although the liquid flux has good properties electrically, it is best removed so that the surface of the circuit can be protected with a suitable varnish. A printed circuit pattern is particularly vulnerable to contamination and deterioration as it is all on the surface where moisture and dust can soon adversely affect the insulating properties. Surplus flux is removed in the same way as the pattern was degreased—by dipping into a shallow tray of trichlorethylene. Fig. 3 shows the complete process.

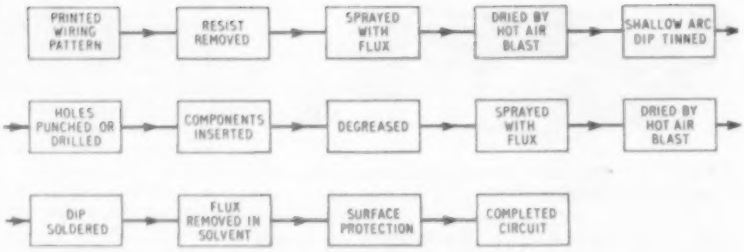


Fig. 3. Diagram showing sequence of processes in dip soldering.

Results.—Circuits have been printed by the double-layer method and treated exactly as described; in all cases the results have been perfect. It might be thought that such a simple system which uses no special apparatus and in particular no vibration by ultrasonic or other means cannot work when other more complicated systems have failed. Vibration breaks up the solder surface and causes dross to form.

In order to test the method, a series of circuit patterns were printed, each about 4 × 3 inches. After they had been treated satisfactorily it was decided to extend the method to as large a board as would probably be used in Service applications. This entailed printing the same circuit four times on a piece of copper-clad laminate, 9 × 7 inches. Anything larger than this would probably be a bad risk because of vibration, but it is doubtful if the number of joints would be exceeded for any but the most complex assembly. There were 330 joints on each board and five such boards were made under identical conditions.

To economise in components, pieces of 0.036-in wire were threaded into 0.040-in holes and bent over with a pair of pliers. One thousand six hundred joints of this type were made without the failure of one. To forestall the criticism that what could be done with clean tinned wire could not be expected with standard components, several circuits were assembled from standard components drawn from stock. In no case were the leads scraped or cleaned in any way other than as described, although it must be admitted that certain resistors were omitted from the test because they are quite impossible to solder by normal means and it is obviously unfair to include this type in the test. In all cases the final results were perfectly soldered joints on a background of nicely shaped wiring patterns.

Future Development.—Soldering of the entire wiring system is not necessarily required. The thickening of the wiring increases its current-carrying capacity, but this is rarely necessary, and the increased weight and cost of the unnecessary solder are undesirable. This means that some method of making the joints without affecting the wiring is required.

Various methods of doing this have been proposed but so far a satisfactory solution has not been found by the writer.

What is required is a solder "resist" made either of a plastic coating or a material such as paper that can be attached to the base in the form of a mask through which only the joints appear for soldering. If a plastic coating is used, it is preferable to be able to spray it on to the base via a mask, leaving only the joints exposed for soldering. One of the problems in finding such a material is that most resins that might be suitable are cured by heating; if this were done in such a way that the exposed copper was attacked or corroded, there would be considerable difficulty in making satisfactory joints during the soldering process.

Conclusions.—It is considered that the simple process outlined is perfectly satisfactory for the dip soldering of sub-assemblies for electronic apparatus for use both by the Services and by the radio and television industry. Its satisfactory use would stimulate the development of a selective soldering system, but for the time being this is not essential.

Components for dip soldering must be capable of being soldered with an iron in the usual way; if they are not, then it is useless to attempt to dip solder them. Terminations that are badly oxidized or have been electro-tinned for a considerable period are unsuitable. Solder-coated, silver-clad or plated wires will usually make very good joints. If they are covered with wax this merely dissolves in the bath; this makes an unpleasant odour and smoke but is otherwise harmless.

Standard components are not damaged when dip soldered as described, although paint finishes and plastic sleeves may be slightly discoloured. The sleeves are rarely necessary as the components are mounted on to an insulating base and further insulation is not required, except when a metal-based component crosses over a printed line. (This applies only to double-sided printed layouts.)

(All diagrams are Crown Copyright.)

New "Wireless Servicing Manual"

A NEW (ninth) edition of "Wireless Servicing Manual," by W. T. Cocking, has just been issued by our Publishers on behalf of *Wireless World*. The book, which has been completely revised and appears in a new format, now deals with sound receivers for f.m./v.h.f. as well as a.m. for long, medium and short waves. Television is not covered.

Emphasis throughout is on principles and methods of testing; similarly, the explanatory diagrams illustrate principles rather than specific receivers. There are 268 pages and 128 illustrations; price is 17s 6d (postage 1s).

Television Pattern Eliminator

Removing Band I Interference on Band III

WHEN a convertor is used for Band III reception, the television receiver proper is normally tuned to the local Band I channel. As a result, there is a risk of the Band I signal being picked up by the signal-frequency circuits of the receiver and so causing interference on Band III. Trouble of this kind is especially likely when the set is of the straight type.

A balancing unit for the reduction of this kind of interference has been produced by Spencer-West. It is available in two forms, known as types 54 and 54A, which differ in the kind of plug and socket connectors provided. The purpose of the unit is to introduce into the receiver a Band I signal which is equal in amplitude and opposite in phase to that directly picked up and which, therefore, cancels it out.

The internal circuit diagram of the Patterning Removal unit is shown in Fig. 1 enclosed in the dotted box. There are two coaxial sockets on the unit and two coaxial-cable leads. For Band I reception, the Band I aerial is connected through the usual internal switching of the convertor to the Band I receiver and the unit is effectively short-circuited.

For Band III, the Band I aerial socket on the convertor is usually short-circuited within the convertor. The cable between the convertor and the balancing unit is roughly $\lambda/4$ in length, so that the short-circuit at the convertor end does not short-circuit the Band I aerial. A $\lambda/4$ length of cable short-circuited at one end has infinite impedance at the other. On Band III, therefore, the connection to the Band I socket on the convertor can be ignored. The Band III signal is then applied to the convertor in the usual way and, after conversion to Band I, is fed to the Band I receiver via the output connections of the balancing unit. A Band I signal is also fed into the receiver through the balancing unit and is derived from the Band I aerial.

When both potentiometers are at their centres, equal signals in opposite phase are fed to the transformer T from their ends and the net output of the balancing unit is zero Band I signal. Moving a slider away from the centre in one direction provides an output in one phase; moving it the other way provides an output in opposite phase.

Because of R and C in the leads to the sliders of P_2 and P_1 respectively, the signals from the two potentiometers have nearly 90° phase difference between them and, by adjusting the two, a combined output of any desired phase and amplitude is obtainable.

As there is considerable attenuation of the Band I signal in the unit, the makers state that it may be necessary to use a good Band I aerial in order to get sufficient output to balance out stray pick-up. The adjustment procedure is to tune in the Band III signal and then to adjust P_1 and P_2 in turn for minimum patterning on the screen.

Some tests were carried out with the unit under very severe conditions and it was found that a precise balance could be secured only at one frequency. This is, of course, to be expected on theoretical grounds and it means in practice that the unit will precisely balance out interference on vision or on sound but not on both together.

The conditions of the test were so severe that the Band III signal could barely be detected through the Band I. It was too much to expect that the unit would remedy this but it did, in fact, enormously reduce the Band I signal. The balancing adjustments proved to be very smooth and definite and the unit behaved exactly in the manner described by its makers, and it was, in fact, necessary to use an H aerial to obtain sufficient Band I input to the unit for a balance.

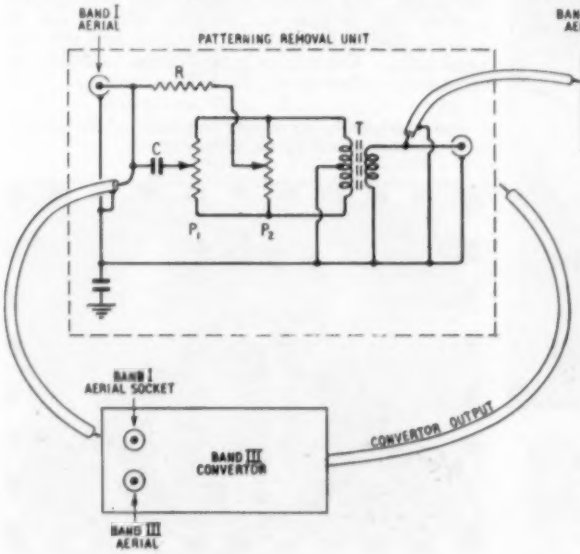


Fig. 1. Pattern removal unit (in dotted box) shown connected to aerials, convertor and receiver.

There is no doubt at all that the unit will do what it is intended to do, which is to remove the pattern produced on a Band III picture by a considerably weaker Band I signal picked up by the receiver. Under such conditions, sound interference is usually negligible and the inability of the unit to be as effective on both is unimportant.

A variable attenuator is made by the same firm and operates on a similar principle in that a centre-tapped transformer is used with one potentiometer. A range of 6-36 dB is obtainable and proper matching at all settings is claimed. The unit is fitted with coaxial connectors.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

Britain at Damascus Fair

SEVEN British radio manufacturers (Bush, Cossor, Ekco, Ferguson, G.E.C., Kolster-Brandes and Regentone) are staging a composite exhibit under the auspices of B.R.E.M.A. at the Damascus International Fair, opening on September 1st. This is the industry's second collective export promotion effort in the Middle East; there was a composite exhibit at the Baghdad Fair in 1954. Sound and vision programmes will be heard and seen at the show. Pictures will come from a television transmitter and studio installed by Pye, who will also have their own separate exhibit. The system used will operate on the 625-line C.C.I.R. standards.

Exports of broadcast receivers to the Middle East countries rose in 1955 by 24 per cent to a value of about £613,000 from £513,000 in 1954. Total exports of all kinds of radio equipment rose during the same period by 13 per cent (from nearly £1,294,000 to over £1,460,000).

Electronics at Earls Court

THE principal feature of the electronics section of the National Radio Exhibition, to open in London on August 22nd, will be the timing equipment used in the record-breaking run of the Fairey Delta II. This exhibit, shown by courtesy of the Royal Aircraft Establishment, Farnborough, will include reproductions of photographic records made during the run.

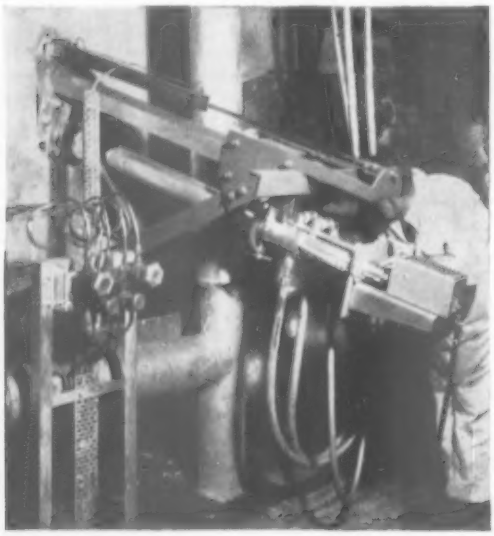
Many facts and figures on the Exhibition and the radio industry are given in a brochure, written in English, French and Spanish, which is being distributed to prospective overseas visitors, the number of which increases year by year.

Television on Tape

RECORDING of video signals on magnetic tape—the subject of much discussion, experiment and exaggerated claims—seems now to have become a really practical proposition with the successful demonstration of a new machine in the U.S.A. and the placing of orders for it by several of the big American television broadcasting concerns.

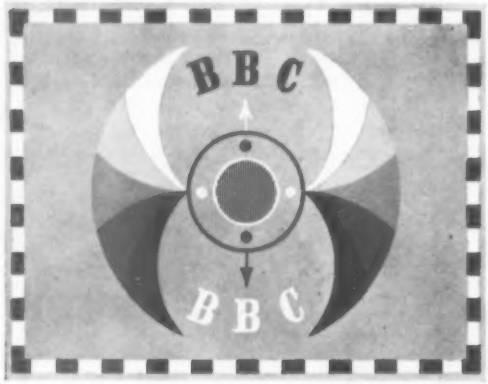
Designed by the Ampex Corporation, of Redwood City, California, it avoids the old problem of having to run the tape at high speed by recording the signals transversely as well as longitudinally on a wide tape (actually 2-inch). This is done with a special head assembly which is said to rotate at high speed across the tape. As a result it has been possible to run the tape at only 15 inches per second, and a 14-inch reel is enough to record a 65-minute television programme. The *effective* tape speed given by this technique, however, is sufficient to record video frequencies up to 4 Mc/s. The accompanying sound is recorded in a conventional manner along one edge of the tape.

The quality of the pictures reproduced from the video tape records has been reported to be far superior to that given by photographic recordings, and equal to or better than ordinary films shown on television. An economic advantage over photographic film is that the recorded picture can be erased when it is no longer required and the tape used again. The cost of a production model of the recorder is given as 45,000 dollars.



PERISCOPIC TV:—The use of television for the inspection of the interior of a furnace was recently demonstrated at Barking power station. The photograph shows the Marconi Videcon camera mounted at the viewing end of a long periscope which is here shown in the 'withdrawn' position. The reproducing equipment can be installed in any convenient part of the station.

New television tuning signal. Resolution of the centre lines indicates about 2.5 Mc/s bandwidth.



PERSONALITIES

H. G. Sturgeon, who, as mentioned in these pages last month, was appointed an O.B.E. in the Queen's Birthday Honours, has been with Ultra Electric, Limited, since 1944. In 1946 he was appointed chief engineer and also became a director of the company. He has been responsible for the development of a considerable quantity of electronic equipment for the aviation industry.

H. G. STURGEON

M. L. JOFEH

M. Lionel Jofeh, A.M.I.E.E., deputy chief engineer of Sperry Gyroscope Company, of Brentford, was also appointed an O.B.E. He joined the company as an equipment engineer in 1947 and subsequently became head of a research group on a special project at the company's Gloucester factory. He returned to Brentford in 1954 and took up his present position. For eleven years prior to joining Sperry, Mr. Jofeh, who is 43, was at Cossor's research laboratories where he worked on radar and guided missiles.

Colonel Sir Stanley Angwin, K.B.E., is relinquishing, on September 30th, the post of chairman of the Commonwealth Telecommunications Board which he has held since 1951. Sir Stanley, who is 72, was for eight years engineer-in-chief of the Post Office until he became chairman of the board of Cable and Wireless in 1947, a position he held until his appointment to the C.T.B. In 1953 he was awarded the Faraday Medal of the I.E.E. "for his outstanding contributions to the development of telecommunications in Great Britain and in the international and intercontinental fields."

E. G. Richardson, B.A., D.Sc., Ph.D., reader in physics at Durham University, has been appointed to a personal professorship of acoustics in the Newcastle division of the university. Dr. Richardson, who is well known in the fields of pure and applied acoustics, is British representative on the editorial board of *Acustica*, the international journal of acoustics.

J. C. Atkinson recently left RCA Photophone, Limited (now RCA Great Britain), of which he had been a director since 1925, and has joined the board of Thermionic Products, Limited, of Hythe, Southampton, and its associated companies.

Patent applications for a simplified tuning system, applicable to both sound and television receivers, have been filed by **John D. Burke,** a contributor to *Wireless World*. He claims that a single unit can tune all broadcast bands from the long wave to Band III, thus reducing the cost of combined A.M.-F.M.-T.V. receivers. In "Fugitive from Pandemonium," in the February 1953 issue, Mr. Burke, who had recently settled in this country, gave an American television technician's reactions to an abrupt change. Ironically enough, having fled from commercial television in the States, he is now on the engineering maintenance staff at the independent television studios, Wembley.

J. C. Evans has joined the Dulci Company as technical sales manager. He received his early training at the Dollis Hill Research Laboratories of the Post Office and was more recently service manager and chief electronics engineer of Continental Radio and Electronics, Limited.

When **F. N. Calver,** M.B.E., retired at the end of April from the position of engineer-in-charge at the B.B.C.'s Daventry transmitting station, **H. A. Masters,** who had been assistant e.-in.-c. since 1949, succeeded him. Mr. Masters, who is 55, joined the B.B.C. in 1930 after service with the Marconi Company and the G.P.O.

OBITUARY

Dr. Heinrich Barkhausen, emeritus professor of the Technischen Hochschule in Dresden, who gave us the "phon" as the unit for the intensity of sound, died recently at the age of 74. He was well known for his research work on valves which resulted in the publication of his book "Elektronenröhren,"and his name has been given to a number of his contributions to radio:—the Barkhausen equation, Barkhausen clicks and Barkhausen-Kurtz oscillator. In recent years, Professor Barkhausen has been head of the editorial board of our German contemporary *Zeitschrift für Hochfrequenztechnik und Elektroakustik*.

J. E. Davies, manager of the technical information and publicity division of the Marconi International Marine Communication Company since 1951, died on June 1st at the age of 63. He joined the company's sea-going staff in 1912 and in 1927 became inspector at the East Ham depot. Two years later he joined the head office technical staff. Mr. Davies had been editor of the *Marconi Mariner*—the company's house journal—since its introduction in 1948.

IN BRIEF

1957 Exhibitions.—The dates of the following radio and allied exhibitions to be held next year have recently been announced by the organizers: Physical Society Exhibition, March 25th to 28th, Royal Horticultural Society's halls, Westminster, S.W.1; Electrical Engineers' Exhibition (A.S.E.E.), April 9th to 13th, Earls Court, London, S.W.5; Components Show (R.E.C.M.F.), April 9th to 11th, Grosvenor House, Park Lane, London, W.1.

Cambridge University has leased a site from the Air Ministry at the R.A.F. station at Lord's Bridge, near Cambridge, for the **Mullard radio-astronomy observatory.** The cost of the erection of the observatory and about half the total cost of the whole project will, it is stated, be met by the recently promised £100,000 gift from Mullard, Limited.

A site has been acquired by the B.B.C. for the second **Northern Ireland television transmitter.** It is some 570 feet above sea level on Sheriffs Mountain, near Londonderry. The new station, which eventually will also accommodate a v.h.f. sound transmitter, is planned to be brought into service towards the end of next year.

The radio-telephone **breakdown service** of the Automobile Association is now operated from nineteen centres and covers an area of some 34,000 square miles. The latest transmitter is at Leicester and additional centres are to be set up in Dublin, Belfast and St. Helier (Jersey), later this year.

Television at the Opera.—Earlier this year Pye installed a miniature television camera in the Vienna State Opera House to enable the chorus master (in the wings) and the organist (in the organ chamber) to follow the conductor of the orchestra more readily. Now at the Glyndebourne Opera House a television camera has been similarly installed by Pye beside the prompter's box for the benefit of the chorus master.

F.M. and Quality.—Commenting on the growing American interest in the quality of the music programmes broadcast by f.m., our New York contemporary, *Audio*, draws attention to an additional attraction for the "hi-fi" audience offered by station WBA-FM. At each hour the station radiates one or more test frequencies ranging from 30 to 15,000 c/s—a worthwhile innovation.

One of the fifty or more articles in the *Financial Times'* annual **Review of British Industry** covers the broadcast receiver manufacturing side of the radio industry and another—by J. F. Lockwood, of E.M.I.—the electronics industry. In dealing with the effects of the credit squeeze the writer of the first article, John Hay, states: "Firms willing to put out a 12-inch or 14-inch set with the minimum of frills and tuneable only over a limited number of channels at a price well below that for the most-favoured 17-inch set with many refinements can expect to secure a bigger share of the market."

Semi-conductors.—Over sixty members of industrial and Government organizations attended a conference on semi-conductor devices at the Borough Polytechnic, London, S.E.1, early in June. This was in the nature of a follow-up to the very successful series of courses of lectures on semi-conductors held at the Polytechnic in the past three years, at which over 700 students attended. A new series of elementary lectures will begin in October and a more advanced course next January.

Members of the **Television Society** elected to fill the vacancies on the council for 1956-1957 are: J. J. Billin (E.M.I.), D. C. Birkinshaw (B.B.C.), S. J. Preston (E.M.I.), E. G. Rowe (S.T.C.) and F. H. Townsend (Cathodeon). Mr. Birkinshaw has again accepted the office of chairman.

I.E.E. Students.—The new chairman and vice-chairman of the committee of the I.E.E. London Graduate and Student section are respectively K. W. E. Gravett (Post Office Research Station) and E. L. Jones (Edison Swan).

The Fellowship of the **Television Society** has been conferred on Professor J. D. McGee, professor of instrument technology at Imperial College (formerly of E.M.I. Limited), C. L. Hirshman, chief radio engineer at the Brimsdown works of Ediswan, and Axel Jensen, head of television research at the Bell Laboratories in America.

Brit.I.R.E. Convention.—Plans are being made by the Brit.I.R.E. to hold a convention—probably devoted to electronics in automation—at King's College, Cambridge, from June 28th to July 2nd next year.

A New Approach.—Writing in the *Financial Times* on the decline in popularity of sound broadcasting, G. Clement Cave, general manager of Radio Luxembourg, states—"For our part we intend completely to revitalize our thinking and our planning. . . . We are approaching the task as though radio is a completely new medium that is about to be launched for the first time on a nation where television has been well established for years."

A.P.A.E.—At the annual general meeting of the Association of Public Address Engineers, V. G. P. Weake, of Pamphonic Reproducers, was elected president in succession to A. H. Whiteley, of Whiteley Electrical Radio.

Eire S.W. Station.—It has been decided by the Eire government to dismantle the short-wave broadcasting station at Athlone, which was set up in 1947 but has not been used for the past few years.

Correction.—The photograph on p. 273 of our June issue was incorrectly described as showing the Cossor "Hydraudyne" oscilloscope. It illustrates, in fact, the Mullard transistor oscilloscope, of which a block diagram was given on p. 277.

AIR ELECTRONICS OFFICER. This badge will be worn by the new R.A.F. category of air electronics officer operating radio and electronic gear, not controlled by the pilot or navigator.

An autumn convention covering all aspects of **air traffic control** is being organized by the Guild of Air Traffic Control Officers for October 4th and 5th at Southend-on-Sea, Essex. It is planned to include an exhibition of manufacturers' equipment and talks and discussions on the design and operation of A.T.C. gear.

From July 2nd the head office of the **Air Registration Board** will be Chancery House, Chancery Lane, London, W.C.2. (Tel.: Chancery 2811.)

A summary of the **applied research** in electrical engineering in progress in university colleges and technical colleges in London and the Home Counties has been prepared by the Regional Advisory Council. Copies of the list, covering 14 colleges, are obtainable from the Council at Tavistock House South, Tavistock Square, London, W.C.1.

A.R.B.M.—The Association of Radio Battery Manufacturers has moved from 41 Gordon Square to 77 Bedford Avenue, London, W.C.1. (Tel.: Museum 0476.)

FILMS AND PUBLICATIONS

Among the new films available on hire from the Central Film Library of the Central Office of Information is "**The first automatic factory.**" It deals with the ECME production line (originated by J. A. Sargrove) which was described in *Wireless World* in April 1947. The 20-minute sound film can be hired for £1 from the Central Film Library, Government Building, Bromyard Avenue, London, W.3. A short sound film, produced by the Automatic Telephone and Electric Company, describing the working of the transatlantic radio-telephone link, is also included in the list of recent film releases. It can be hired for 5s.

Mullard Films.—In addition to arranging film meetings for the radio trade Mullard also cater for the needs of amateur radio societies. Club secretaries can secure details of films and lecture material from the Films and Lectures Organization, Mullard, Ltd., Century House, London, W.C.2.

S.I.M.A. Directory.—The 1956 edition of the directory and handbook of the Scientific Instrument Manufacturers' Association includes a glossary of the complete range of the scientific instruments manufactured by the 130 members of the Association of which a large number manufacture electronic gear. Over 200 pages are devoted to members' announcements giving further details of their products. The handbook is obtainable from S.I.M.A., 20 Queen Anne Street, London, W.1, price £1 2s 6d (post-free).

On June 6th, the Institution of Post Office Electrical Engineers celebrated the 50th anniversary of its foundation. The October issue of the *P.O.E.E. Journal* will be a **jubilee number** which will be devoted to articles reviewing the development of the Post Office telecommunications services during the past half-century.

A set of three **wall charts,** measuring 19in by 24in, showing diagrammatically in colour the basic principles of radio have been produced by Educational Productions Limited. Published in collaboration with E.M.I. Institutes, the set of three charts (1, amplification; 2, the resonant circuit; 3, the superhet) are obtainable from Educational Productions Limited, 17 Denbigh Street, London, S.W.1, price 3s.

FROM ABROAD

Canadian I.R.E. Convention.—The first convention and exhibition to be staged by the Canadian section of the American Institute of Radio Engineers is to be held in the Automotive Building, Exhibition Park, Toronto, from October 1st to 3rd.

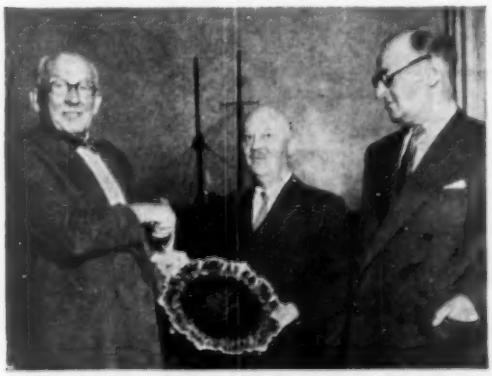
Propagation Problems.—An international meeting on the propagation of radio waves is to be held in Paris from September 17th to 22nd. The four main sessions will cover the propagation of metric, decimetric and centimetric waves beyond the horizon; influence of the ground on radiation and propagation; ionospheric propagation; and miscellaneous matters including "whistling atmospherics." Particulars are obtainable from the Société des Radioélectriciens, 10 avenue Pierre-Larousse, Malakoff (Seine), France.

As a result of the international congress on **analogue computing** held in Brussels last autumn, the Association Internationale pour le Calcul Analogique has been formed for the exchange of scientific information on analogue computers and the organization of international meetings. Particulars of the Association are obtainable from R. Peretz, 50 avenue F. D. Roosevelt, Brussels, Belgium, from whom copies in English or French of the proceedings of last year's meeting are also obtainable.

"**Radio Philatelia**" is the title of a 48-page book published in the U.S.A. in which the author, Herbert Rosen, traces the history of telecommunications as depicted on postage stamps. The stamps, which are illustrated and briefly described, are grouped under such headings as inventors, telegraphy, telephony and various aspects of radio. The publishers are Audio-Master Corp., 17 East 45th Street, New York 17, N.Y., and the price 2 dollars.

BUSINESS NOTES

Radio and Allied Industries, Limited, manufacturers of Sobell receivers, are seeking to acquire **McMichael Radio, Ltd.** It would remain a separate commercial organization with its own limited dealership arrangements for the sale of McMichael receivers, etc. The board would be reconstituted and of the existing directors H. F. Buckmaster and C. G. Allen would be on the new board.



FIFTY YEARS of capacitor manufacture were recently celebrated by the Telegraph Condenser Company which, except for its recent entry into the field of printed circuitry, has throughout specialized in the production of capacitors. In this photograph, taken at a gathering of 2,000 employees and friends, P. V. Hunter (chairman) is presenting P. A. Sporing (director and general manager) with a silver salver. On the right is W. F. Taylor (director and general sales manager).

Although **Pye Telecommunications** "continue to recommend a.m. for all new [marine radio-telephone] installations" they are to produce a frequency-modulated version of the Ranger marine radio-telephone equipment mainly for export.

Orders for 112 radar reflectors for ships' lifeboats have been received by **Marconi Marine** from four shipping companies. The reflectors, which are collapsible for easy stowage, are of the corner octahedral design to ensure a good radar echo from any bearing.

Simon Equipment, Limited, have received an order from the Ministry of Supply to install multi-channel long-duration tape recording equipment at the Thurleigh Airfield, Bedford. The equipment is similar to that installed in the control tower at the Royal Aircraft Establishment, Farnborough, last year. Simon have also recently supplied multi-channel recording equipment to India and Malaya.

Pye Marine, Limited, have recently brought into operation a new wing of 13,500 square feet at their factory at Lowestoft, Suffolk. The company are producing the sound reproduction and loud-hailing equipment for all the twenty trawlers being built for the Russians at the Brooke Marine's yard, Lowestoft.

The Manchester depot of **Aerialite, Limited,** and its associates, Nettle Accessories, Limited, has been moved to larger premises at 355, Deansgate, Knott Mill, Manchester, 3. (Tel.: Blackfriars 2604.)

The technical sales office of **Hallam, Sleigh and Cheston, Limited,** manufacturers of Widney Dorlec cabinets, has been moved from London, S.W.6, to Oldfield Road, Maidenhead, Berks. (Tel.: Maidenhead 4311.)

Cleminson's Agencies, Limited, of 36 Clifton Gardens, London, N.W.11, advise us that they have been appointed representatives to the wholesale trade for the new Band I/III convertor made by Teleconversions, Ltd. This turret tuner is available for use with receivers with series or parallel heaters and for three different sets of intermediate frequencies.

Communication Systems Limited, a subsidiary of the Automatic Telephone and Electric Company, of Liverpool, are supplying the base station and transmitter-receivers for eleven ambulances of the Wallasey Corporation.

The **Marconi** radar installation in the Pacific Steam Navigation Company's new 20,225-ton passenger liner, *Reina del Mar*, includes a 15-inch display unit. The company has also fitted the radio-communication gear. The sound recording and reproducing equipment in the liner, including a 175-W amplifier, tape recorders and 170 loudspeakers, is supplied by **G.E.C.**

EXPORTS

Marconi transmitting and receiving equipment and d.f. gear was installed in the Vickers Viscount aircraft which the **Pakistan** government purchased for the use of the President.

During the recent State visit to **Sweden,** a display of British goods was staged in Stockholm by the Council of Industrial Design. Three radio receivers were shown: Pilot portable (BM90), Ferranti table receiver (255) and Roberts' portable (R55).

India.—A contract for the supply and installation of harbour radar (Type 32) at the newly-developed port of Kandla in the Gulf of Kutch has been placed with Decca. They are also supplying radar installations for the Saugor and Khander Island lighthouses at the approaches to Calcutta and Bombay.

The Shell Company of Pakistan have ordered a chain of four Decca Navigator stations to be set up in **Eastern Pakistan.** The chain will provide coverage in the Bay of Bengal and the adjoining land areas.

Crystal-Controlled F.M. Receiver

Three-Programme Switch Station Selection

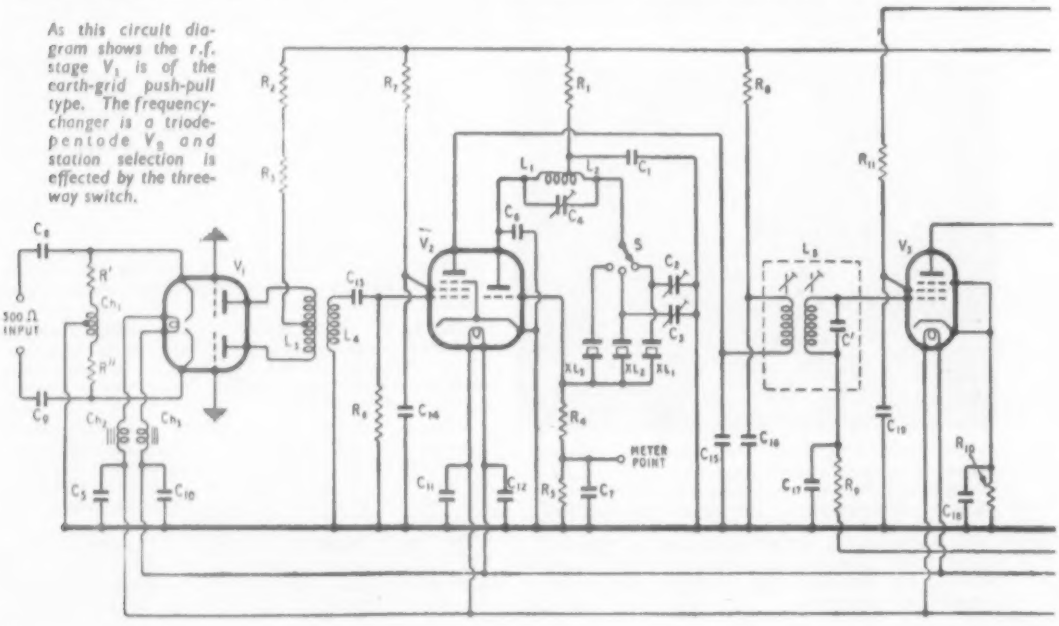
BY D. N. CORFIELD*

SINCE in any one area there are normally only three f.m. programmes radiated on a group of frequencies spaced 2.2 Mc/s apart a tunable receiver is unnecessary and all that is required is a three-station receiver. Such a receiver could have a three-station switch or a remotely operated push button with an electro-mechanical switch to select the station. One of the principal bugbears of push-button-tuned receivers has always been the troubles arising from the frequency drift of the local oscillator. Avoidance of this drift on the medium waveband is not easy and in Band II it is much more difficult because of the higher frequency and because the effect of the drift is so detrimental to the quality of the audio output. In a normal Band II receiver some drift is permitted while the set is warming up, but after about 10 minutes the temperature-compensation circuits should be operative and little further drift should take place; however, if there is any this can be readily corrected by slight retuning.

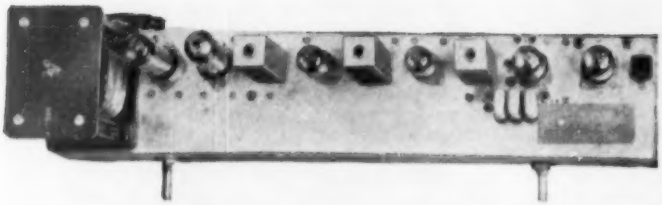
In a push-button receiver no appreciable drift is allowable at any time, and it is believed that such an exacting requirement cannot be met with a switched oscillator at 80 Mc/s bearing in mind that the switch will introduce both variable inductance and resistance and there will be in addition both extremes of temperature and variation of mains voltage. The obvious solution to the problem is to employ a switched crystal-controlled local oscillator; this system is commonly employed in commercial multi-channel ground and airborne equipment with every success. It has been common practice to employ a relatively low frequency crystal and a chain of harmonic multipliers to generate the local-oscillator frequency, this system is costly, complicated and would not commend itself to the average listener, particularly as the process of harmonic generation could produce spurious responses in the receiver on some channels and could cause interference on the short wave and television bands.

Harmonic oscillators are known to lead to a poor signal/noise ratio at the mixer stage unless special care is taken to filter the output from the multiplier chain. The most modern practice, however, is to use overtone crystals which generate the local-oscillator frequency directly and as these are now available for frequencies up to about 100 Mc/s they appeared to be an obvious choice. To cover the f.m. band crystals around either 80 Mc/s or 100 Mc/s are necessary and as the lower frequencies are both cheaper and more readily available it was decided to operate the mixer with the oscillator "low," hence for Wrotham, as an example, the crystals are 78.4,

* Standard Telephones & Cables Ltd.



As this circuit diagram shows the r.f. stage V_1 is of the earth-grid push-pull type. The frequency-changer is a triode-pentode V_2 and station selection is effected by the three-way switch.



Top view of the receiver chassis, including power supply.

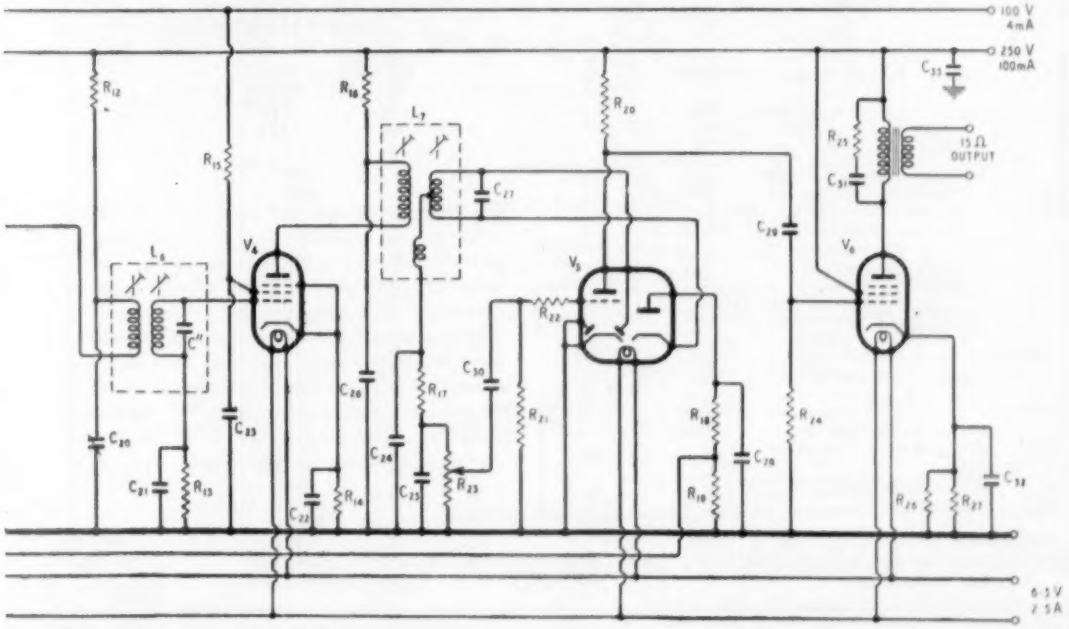
80.6, and 82.8 Mc/s respectively, assuming the use of the standard 10.7 Mc/s i.f. The writer has never delved in the past to find out why this frequency was originally chosen. It is, however, in a convenient part of the spectrum for obtaining the necessary bandwidth of i.f. transformers and discriminator and having been standardized in the U.S.A. and the Continent it is an obvious choice for the U.K., particularly as 10.7 Mc/s components are readily available.

The Receiver: Two versions of a basic crystal-controlled receiver have been built. The one described here employs a manually-operated three-programme switch to select one of the three crystals and is complete with a normal pentode output stage supplying the loudspeaker directly. The illustrations show the form of layout that can be employed.

It was thought desirable to design the basic receiver with a reasonably high sensitivity so that it could be used in fringe areas; with this in mind, and to reduce the possibility of interference radiated from the oscillator, an r.f. stage is embodied. The use of 300-ohm balanced feeder is fairly common practice on the higher v.h.f. bands on account of its low cost and low losses. The r.f. stage has accordingly been designed for a balanced 300-ohm input. The mixer is of a type more commonly employed for Band III television and is a triode-pentode valve, the pentode performing the function of a mixer and the triode of an overtone crystal oscillator. Two i.f. stages are used in order to ensure good sensitivity, the first stage has automatic gain control to prevent the discriminator diodes being run above their rated current if the signals received are exceptionally strong. The discriminator is of the ratio type and uses an unbalanced arrangement of the circuit as it is known that this type, as opposed to the balanced type, can introduce two or three times less hum. A treble-diode-triode valve is used, the triode operating as a first-stage resistance-coupled a.f. amplifier.

Circuit Description: The r.f. stage V_1 is a double-triode used as a push-pull earthed-grid amplifier; no tuned circuit is used for the input. The two capacitors C_3, C_9 isolate the feeder from the cathodes.

Two alternative cathode circuits are permissible. The neatest is to omit R′ and R″ and to wind Ch_1 with resistance wire so that it has a resistance of 200 ohms on each side of the tap. No. 48 gauge nickel-chrome alloy wire can be used and a length of about 20 in. for each side is needed. A resistor can, of course, be used for the former in the usual way. Wire of this sort is not too easy to handle, nor can it readily be obtained in very small quantities. As an alternative, therefore, the choke can be wound with No. 38 gauge copper wire and the resistance obtained by inserting R′ and R″ of 200-Ω each. They should preferably be of the ½-W type, but ¼-W will do. A 6BQ7A will give rather more gain and lower noise than an ECC85 but is less readily available. The centre tap of the push-pull anode coil L_3 is not earthed but floating because of R_2



which is connected directly to the centre tap; R_7 is an additional series resistor to drop the anode voltage to about 150. The grids of V_1 are earthed to the chassis on the valve socket and the heaters are supplied via two dust-cored chokes, Ch_2 and Ch_3, decoupled with lead-through capacitors C_8 and C_{10}.

The mixer grid coil L_4 is mounted inside L_3 and as a pair they have a sufficiently wide bandwidth to cover the three stations, they are adjusted by concertina-ing the turns in and out slightly to give maximum gain on the middle channel. The pentode section of valve V_2 is used as a mixer (leaky-grid fashion) with grid-leak (R_6) bias and no cathode bias; the capacitor C_{12} is the grid capacitor, the screened grid (g_2) being supplied at about 100 volts by R_7 decoupled by a lead-through capacitor C_{14}.

The triode of V_2 is used as the crystal oscillator in a "Squier" circuit. The grid leak is R_4 and provision is made for checking the grid current at the meter point across R_5 decoupled by C_7. Anode voltage is supplied via a series resistor R_1 decoupled with a lead-through capacitor C_1 to a tap on the tuned circuit L_1, L_2 and C_4. XL_2 crystal is the highest-frequency crystal of the trio, and in this position of the switch C_4 is tuned for the maximum stable oscillation (see lining-up procedure). When the switch is on XL_3 or XL_1 additional trimmers, C_3 and C_2, are brought into circuit progressively to tune L_1, L_2, C_4 to a lower frequency. Since on these positions C_3 or C_2 load one end of the tuned circuit, they tend artificially to move the position of the tap, which being off-centre provides some regeneration which is essential for the operation of overtone crystals. The capacitor C_6 is chosen to load the other end so that on the middle frequency (XL_2) the correct loading is restored: it is, however, a little out one way or the other on XL_1 and XL_3 but this is of no consequence. There is sufficient coupling between the oscillator and mixer in the layout, and within the valve V_2 and its valveholder, to provide adequate peak heterodyne voltage. The value of this voltage can be ascertained by connecting a microammeter in series with the "earthy" end of R_6, the current should be of the order of 10 μA. The common heaters of V_2 are decoupled with lead-through capacitors C_{11} and C_{13}. The anode of the mixer is connected to the primary of the first i.f. transformer L_5 and the anode supply obtained via R_8 decoupled by C_{16}. C_{15} tunes the primary winding of L_5 but is connected directly to chassis at the valveholder in order to bypass any Band II signal present in the anode circuit.

The secondary windings of the first and second i.f. transformers are tuned by 5-pF capacitors mounted within the transformer cans but the second i.f. transformer primary winding differs from the first in that it has no tuning capacitor. The circuit arrangement of V_3 and V_4 are similar as regards supply voltages, the screen voltage being derived from a 100-volt supply as the use of a sliding screen (series resistor) would increase the grid base too much for a.g.c., a grid leak R_{13} and capacitor C_{21} by their limiting action prevent V_4 being driven into excessive grid current with very strong signals. R_9 and C_{17} decouple the a.g.c. line to V_3.

The anode of V_4 is connected to the primary winding of the discriminator L_7. The secondary winding is tuned by C_{27}, which must be of a type

(*Continued on page 315*)

COMPONENT VALUES AND CHIEF PARTS

Coils:

	I.F. coil formers and cans, Aladdin PP5937
	Dust cores for L_5 and L_6 (2 each), Neosid 500 mat.
	Dust cores for L_7 (2), Neosid 900 mat.
	Dust cores for Ch_2 and Ch_3, Neosid CH1. (Each fully wound with No. 24 enam. wire.)
L_1, L_2	10 turns total No. 18 enam. wire tapped at 3 t. for L_2, leaving 7 turns for L_1. Inside diameter $\frac{1}{4}$in.
L_3	18 turns No. 18 enam. wire. Inside diameter $\frac{1}{4}$in.
L_4	8 turns No. 18 enam. wire. Inside diameter $\frac{7}{16}$in. Fitted outside L_3.

Crystals:

See text. S.T.C. Type 4046

Valves:

V_1	6BQ7A or ECC85
V_2	6U8 or ECF82
V_3, V_4	6BJ6
V_5	6T8 or EABC80
V_6	EL84 or 6BQF

Capacitors:

Where particular kinds are specified their use is important.

Capacitors (continued)

C_1	820pF lead-through
C_2, C_3, C_4	10pF air-dielectric trimmers
C_5	820pF lead-through
C_6	3pF ceramic
C_7	1,000pF
C_8	47pF N750K
C_9	47pF N750K
C_{10}, C_{11}, C_{12}	820pF lead-through
C_{13}	47pF N750K
C_{14}	820pF lead-through
C_{15}	20pF ceramic
C_{16}—C_{23}	0.01μF
C_{24}	300pF
C_{25}	1,000pF
C_{26}	0.01μF
C_{27}	40pF silver mica
C_{28}	2μF, 50V electrolytic
C_{29}, C_{30}	0.05μF
C_{31}	0.01μF
C_{32}	30μF, 12 V electrolytic
C_{33}	0.01μF
C', C''	5 pF fitted inside cans of L_5 and L_6

Resistors:

All resistors $\frac{1}{2}$-W rating and $\pm 20\%$ tolerance unless otherwise stated.

R', R''	200Ω (see text)
R_1	22kΩ
R_2	4.7kΩ, 2W
R_3	1kΩ
R_4	3.9kΩ
R_5	150Ω
R_6	270kΩ
R_7	68kΩ
R_8	1kΩ
R_9	220kΩ
R_{10}	68Ω
R_{11}	1kΩ
R_{12}	1kΩ
R_{13}	220kΩ
R_{14}	68Ω
R_{15}	1kΩ
R_{16}	1kΩ
R_{17}	47kΩ
R_{18}, R_{19}	18kΩ, 18kΩ To be matched within 2%
R_{20}	470kΩ
R_{21}	10MΩ
R_{22}	47kΩ
R_{23}	500kΩ log-law
R_{24}	470kΩ
R_{25}	1kΩ
R_{26}	150Ω
R_{27}	1.2kΩ

BRIMAR

the *TRUSTWORTHY* safeguard

for Communications and Industry

The special Trustworthy high quality valves have been designed to give maximum efficiency with reliability —most valuable in equipment required to operate for lengthy periods unattended. Primarily established to meet Service requirements, the Trustworthy techniques, including shock and vibration tests, have been extended to include many commercial types. The accompanying table shows the complete range of Industrial "T" valves, most of which are obtainable with reasonable delivery. In many instances additional types can be made available for special applications.

INDUSTRIAL T RANGE

T Code	Equivalent Commercial Type Code	Function	Base
6058	6AL5	Double Diode	B7G
G/6516	6AM5	Power Pentode	B7G
6064	6AM6/8D3	High Slope R.F. Pentode	B7G
G/6066	6AT6	Double Diode Triode	B7G
G/5749	6BA6	Vari Mu R.F. Pentode	B7G
G/5750	6BE6	Heptode Mixer	B7G
G/6059	6BR7	Low Noise A.F. Pentode	B9A
G/6061	6BW6	Output Beam Tetrode	B9A
G/6132	6CH6	Video Output Pentode	B9A
G/6100	6C4	Triode Amplifier	B7G
G/6180	6SN7GT	Low Mu Double Triode	Octal
6063	6X4	Full Wave Rectifier	B7G
6065	9D6	Vari Mu R.F. Pentode	B7G
G/6060	12AT7	High Slope Double Triode	B9A
6067	12AU7	Low Mu Double Triode	B9A
6057	12AX7	High Mu Double Triode	B9A
G/6158	13D3	Special Purpose Double Triode	B9A
G/6062	5763	V.H.F. Beam Tetrode	B9A
G/6157	R17	Half Wave Rectifier	B9A
G/6443	R18	Half Wave Rectifier	B9A
G/6L6GA	6L6GA	Output Beam Tetrode	Octal
G/25L6GT	25L6GT	Output Beam Tetrode	Octal
G/6042	25SN7GT	Low Mu Double Triode	Octal
G/50C5	50C5	Output Beam Tetrode	B7G

Notes: Type 6058 will be superseded eventually by Type 5726 (Short Bulb Version).

Standard Telephones and Cables Limited

Regd. Office: Connaught House, 63, Aldwych, London, W.C.2

FOOTSCRAY · SIDCUP · KENT · FOOtscray 3333

THE ACOS MIC 36

The ACOS MIC 36 crystal microphone performs as well as it looks. It is omni-directional, highly sensitive, and has a substantially flat response from 30 to 7,000 c/s. It retails at £3.3.0 without switch or £3.8.0 with one, and is widely chosen for tape and disc work, P.A. and amateur radio.

TABLE

MIC 36 is just one popular example of ACOS Microphones. The range includes other models retailing at prices from £1:5 to £12:12.

acos always well ahead

ACOS devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

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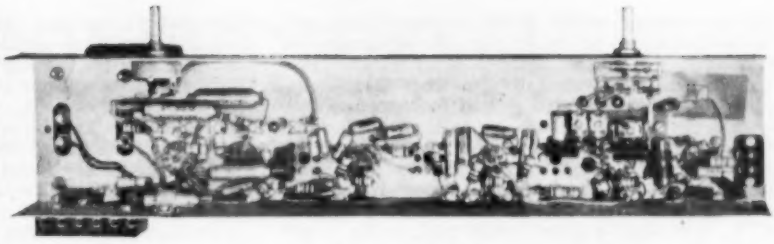
having low capacitance drift (silver mica), and connected to the independent diode cathode (pin 3) of V_5 and the other diode anode (pin 1). The anode of the independent diode (pin 2) is connected to the discriminator d.c. load which is composed of two equal resistors R_{18} and R_{19}, these are shunted by C_{28}, which should have a low leakage up to 50 volts d.c. compared with the sum of R_{18} and R_{19}. The d.c. load is split into two equal resistors for the purpose of achieving a simple lining-up procedure, the tap also being employed for a.g.c. to V_3.



Under view of receiver.

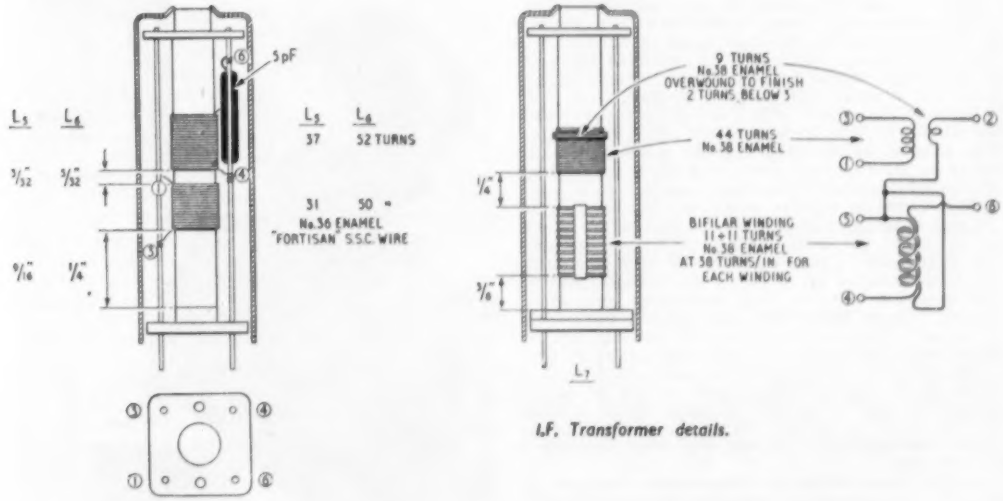
The audio output is taken from the tertiary winding of L_7 and is decoupled to i.f. by C_{24}, C_{25} and R_{17}. As the a.f. output voltage of the discriminator is quite small the triode of V_5 is operated with no cathode bias, which enables the cathode to be earthed, the bias being furnished by contact potential developed across R_{21}.

The output stage V_6 is conventional, the output transformer TR_1 being chosen to suit the type of loudspeaker; the ratio should be selected to give a load of 5,200 Ω on the valve. It will be noticed that two bias resistances in parallel are shown for V_6. This is merely to enable the required and non-standard value of 135 Ω to be obtained with standard-value resistors. Any alternative output stage, which needs the same order of signal to drive it, may, of course, be used.

Alignment: As there is only one variable involved in these receivers, namely the i.f., they can be aligned on the actual station providing the i.f. is sufficiently near for a signal to be received. Otherwise, and in the absence of a calibrated oscillator or signal generator, a short-wave broadcast or communication receiver can be successfully employed for this purpose. If the short-wave receiver is tuned to a frequency lower than the scale marking by its intermediate frequency its mixer oscillator will usually provide sufficient signal at the aerial terminal for alignment purposes. For example, if the i.f. is 465 kc/s, the receiver should be tuned to 10.7 Mc/s–465 kc/s, i.e., 10.235 Mc/s; the nearest approximate marking may be 10.2 Mc/s or 29 metres.

A wire should be connected between the aerial terminal of the short-wave receiver and the mixer grid of the f.m. receiver V_2, the crystals being temporarily removed. A voltmeter should be connected across the discriminator diode load R_{18}/R_{19} between the diode anode and the chassis. The meter should be of the high-resistance type, say, 1,000 ohms/volt and range about 5, 10 or 25 volts.

The dust cores of L_5, L_6 and the primary of L_7 should be tuned for a maximum reading, the secondary of L_7 can be tuned anywhere to produce a reading. The i.f. amplifier is now approximately aligned. The crystal circuit is adjusted by turning the programme switch to the highest-frequency channel and connecting a milliameter range 0–2 mA in series with the triode grid leak R_4 of V_2 or a voltmeter range 0–1 volt across R_5. If the trimmer C_4 is increased in capacitance it will be found that the grid current increases slowly and at some point suddenly falls, indicating that the crystal has ceased to control the oscillator; the trimmer is correctly set if it is adjusted to a point just before this fall.



I.F. Transformer details.

The programme switch should be operated to and fro several times to ensure that the adjustment is such that the crystal controls every time. The switch should be tuned to the other frequencies C_2 and C_3 being adjusted so that consistent control occurs, the grid current being of a similar order. C_4 must not be readjusted for the other frequencies. If the heterodyne voltage applied to the mixer grid requires to be checked, a meter reading of about 10 μA should be obtained in the earthy end of R_{25}, representing about 3 volts peak on the mixer grid. This reading should not be taken until L_3/L_4 have been aligned to the middle channel as the reading obtained depends on the tuning of L_3 and L_4 and on the adjustment of C_2, C_3, C_4.

If the programme switch is operated to the middle channel of the three, the connection of a Band II aerial should now produce a B.B.C. signal which may operate the voltmeter and also produce a distorted sound signal.

The cores of L_5, L_6 and the primary of L_7 should now be accurately aligned for a maximum reading, the turns of L_3 and L_4 should also be concertinaed in and out for a maximum reading. If L_3/L_4 do not appear to be tuning correctly, and it is not known if the circuit is tuning high or low, this can be checked by inserting into the centre of the coils a brass rod or a thin dust core. If the former increases the reading the turns require opening out and if the latter increases the reading they require closing up. Lastly, the meter on a low range should be connected between the junction of R_{17} and C_{24} and the junction of R_{18} and R_{19}. The secondary winding of L_7 should then be adjusted to zero reading (turning this core will cause the meter to read either way of the zero).

Crystals: It should be noted that the frequencies of the crystals employed must be selected to suit the particular f.m. stations it is desired to receive. Their nominal frequencies must be 10.7 Mc/s less than the frequencies of these stations. The crystals are supplied in sets with a close tolerance on their frequency differences but a wider tolerance on their absolute values. It is because of this that it is recommended that the final alignment of the i.f. amplifier be carried out on a signal, for this automatically allows for variations in the absolute values by shifting the i.f. appropriately.

Power Supply: Details of the mains equipment are not given since it is entirely conventional. It must provide 250 V at 100 mA and 100 V at 4 mA for h.t. and 6.3 V at 2.5 A for the valve heaters. The 100-volt screen supply can be derived from the 250-volt line by a potentiometer consuming about 10 mA in the lower limb.

SELECTIVE "PAGING" SYSTEM

SOMETHING different in paging systems was recently demonstrated in London. It is different in that, although the calls are personal, the person called is free to move about and yet is always within hailing distance.

The system depends on the setting-up of a r.f. induction field in a loop surrounding the building. This is fed from a central 25-watt transmitter and control unit and the system operates within the band 75 to 87 kc/s. Transistor receivers carried by the persons to be called are each tuned to one of 50 calling frequencies, spaced 250 cycles from each other.

With a 25-watt transmitter one loop is sufficient under average conditions to cover an area of between 20 and 30 acres; the buildings served within this area may be up to six storeys high. If screening exists between floors a second loop half-way up the building is connected in series with the one on the ground floor.

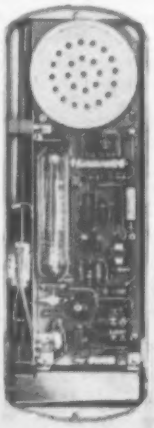
Basically the control unit is an oscillator incorporating 50 crystals, one for each of the calling frequencies. The selected calling frequency and audio signals are fed to the transmitter, the output of which is adjustable to allow for various loop impedances.

The transistor receiver measures 7$\frac{1}{4}$in by 2$\frac{1}{2}$in by $\frac{7}{8}$in and, weighing only nine ounces with battery, it can be carried in the breast pocket. It has no controls, but incorporates a mercury switch so that it is automatically switched on when in the vertical position. The miniature built-in crystal loudspeaker gives ample volume without necessitating the receiver being held to the ear. Power is from a four-volt mercury cell. A ferrite rod aerial is mounted inside the plastic case.

The selective calling system is achieved through a crystal filter circuit, tuned to one of the 50 calling frequencies, and a "gating" transistor which controls the h.t. to the a.f. stages. In the quiescent state the battery consumption is 2.2 mA, and when receiving a call 5.5 mA.

British Communications Corporation, Limited, of Wembley, Middlesex, the manufacturers of the "Radiopage," as it is called, claim that with average use a battery lasts about 500 hours. The cost of a complete installation with 50 receivers is £2,500.

It should be added that although radiation outside the loop is limited to but a few feet, the G.P.O. has stated that a licence is needed.



SEMI-CONDUCTORS—1

A Simple Guide to the Terms Used in Literature on Transistors

By "CATHODE RAY"

SOME readers may have been wondering why I say hardly anything about transistors. It is not because I am against them on principle. One reason is that when transistors first appeared it was clear that at least several years would elapse before they were fit for popular use. Apart from the few enthusiasts who like to follow everything from the start and who can be relied upon to find the information for themselves, it is not very satisfactory to be given a rather difficult explanation to digest and then have to wait years until the subject becomes really topical, by which time we have probably forgotten most of it —which may be just as well, because in the meantime it has become obsolete.

It would be quite reasonable to classify transistors as valves—in fact some authorities prefer "crystal valve" to "transistor"—but the name "valve" has so long been associated with the "bottle of vacuum" or thermionic kind that I am going to use the term in that generally accepted sense. Although in some ways transistors are very like valves, their inner workings are more difficult to grasp, and in some respects they behave in actually opposite ways. (It was this oppositeness that I tried to bring out in my one previous deflection into the transistor field*.) So it seemed best to defer tackling this rather formidable subject until there were signs that transistors would soon appear on the commercial market in a big way.

Prices of Transistors

About a year ago Dr. ("Father of the transistor") Shockley prophesied that an "explosive" growth in transistor production would occur when their price fell below that of valves, probably some time in 1956 or 1957. The doubtful part of this forecast, it seems to me, is the assumption that the price of transistors *will* fall below that of comparable valves. Perhaps in America it will; but as regards this country, with the example of valve *v.* metal rectifiers before us for so many years, I should expect the prices would be cunningly adjusted to a nice balance. However, even if the growth of transistors never reaches flash point, I am sure it is going to be rapid enough from now on to make it worth while addressing our minds to the task of understanding how they work.

There is already a large literature on transistors, and they have by no means gone unmentioned in *Wireless World*; why write more? Well, as I have just said, many people may be only just deciding that it is time they knew something about them, and have missed what appeared earlier. Then there has been a marked tendency for literature on the subject either to say it isn't necessary to know how transistors work in order to be able to use them, or else to plunge into Fermi-Dirac and wave mechanics and all that, to the confusion of the earnest plodder. I suspect that there are a large number of people who would like a simple picture of what goes on in transistors, to hang up in their minds alongside the picture they already have of what goes on in valves—the nice clear picture of electrons boiling off from the hot cathode and streaming across to the attractive anode, to an extent controlled by raising or lowering the potential of the intervening grid. Now although things that began by appearing so abstruse as to be intelligible only to honours graduates have a way of coming within reach of the masses (radar during the last war, for example), and transistors will no doubt soon be included in the most elementary communications courses, I think it is fair to say that the picture must inevitably be a little less simple. The delightful thing about the vacuum valve is that its essential principles really are very simple. The picture of gas-filled valves is more complicated because of the gas ions. Transistors are more complicated still, if one takes into account all the internal actions that are important; to say nothing of the fact that nobody yet quite knows what all these actions are.

One thing we shall see is that the complicated picture of some of the actions can be replaced for routine purposes by a more condensed description, the details being, as it were, "understood." What I am rather afraid of is that the details may appear so formidable that they never will be understood, and the condensed descriptions of the movements of electrons and "holes" will just be accepted as arbitrary facts. No doubt a lot of self-styled "radio engineers" manage to clear faults in customers' sets on a basis of arbitrary facts; for example, that a strangled sort of sound from the loudspeaker of a portable is the signal for another opportunity to sell a battery; but that is hardly likely to satisfy *Wireless World* readers. On the other hand, to attempt to paint the full picture at one sitting by studying the recognized treatises will be too much for the people I have in mind. As I said in the March issue, such people, of whom I am one, need time for new ideas to sink in, and the best thing is first to make a simplified sketch, and when that is clear in the mind fill in the details. I only hope that the necessary simplifications will not make the physicists squirm too much.

Currents in Solid Conductors

Our sketch must start with the basis for all the several distinct kinds of transistors, as well as crystal rectifiers and doubtless other things still to be invented—semi-conductors. The reason vacuum valves are so easy is that the vacuum gives the electrons released from the cathode a clear space in which to work, and, since electrons are all absolutely identical negative electric charges, it is relatively

* "Duals," April, 1952

simple to calculate what they will do in given conditions, and still simpler to visualize their movements (which are electric currents) in a broad, general way.

Electric currents in solid conductors such as wires are much more complicated theoretically, because most of the material is more or less fixed and one has to account for the presence—to very different extents in different materials—of electrons capable of constituting currents. That in itself is quite a difficult study if one goes into it at all deeply. And then, having explained the presence and density of the electrons, one has to consider how their movements under the influence of an e.m.f. are affected by the jungle of fixed atoms through which they have to percolate. I don't think it would be unjust to suspect that the great majority even of professional electrical engineers know and perhaps care very little about all this. Fortunately for them, for nearly all practical purposes it works out very simply, and all they need is Ohm's law and a list of the few important electrical circuit materials with their conductivities (or resistivities) and temperature coefficients. Given these, and the dimensions, material and temperature of any part of a circuit, and the e.m.f. applied, it is routine stuff to calculate the current that will flow. Quite often it may not even be necessary to bother about the temperature, because for most ordinary conductors—metals—the resistance does not vary steeply with it.

Current flow through insulators is less simple, but so long as one takes care always to use good insulators one can dismiss the subject in the terse manner of the schoolboy on "Rabbits in Greenland" (or wherever it was there weren't any). Even moderate insulators conduct something like 10^{20} times less than metals.

In between the very good conductors (usually called just "conductors") and the very bad conductors (insulators) there are some substances that are neither—semi-conductors. It is not simply a matter of their conducting millions of times less than metals and billions or trillions of times more than insulators. Their whole electrical behaviour is most peculiar. Take germanium, which is now the best known semi-conductor although only a few years ago it was little more than a name in the table of chemical elements. Two apparently identical pieces, both absolutely pure so far as the most delicate chemical analysis can show, might differ in conductivity by more than a hundred to one. Again, a piece of apparently pure germanium might pass current readily from one end to the other but not in the reverse direction. And whatever the conductivity happens to be, it depends very much on temperature, and in an apparently capricious manner.

The reasons for these peculiarities involve very large chunks of both chemistry and physics, especially the modern parts that are so difficult because they cannot be accurately expressed in terms of anything we can see or visualize. Our sketch will have to consist of highly simplified versions of the bare essentials.

Structure of Atoms

Every substance consists of one or more of the 92* chemical elements. The differences between these elements result from the structure of their atoms, which are the smallest portions of them that can exist. Each atom consists of a central nucleus surrounded by one or more electrons. It is often likened to a sub-miniature solar system, the nucleus being the sun and the electrons the planets. In some respects that is a very good picture, because it helps one to realize that an atom consists mainly of empty space, so that anything shot at it from outside is likely to go right through without hitting any of the parts. But it mustn't be taken too literally; in particular, the idea of electrons as solid balls revolving round the nucleus in clearly defined orbits is very naïve according to modern teaching. Any attempt to bring electrons sharply into focus seems doomed to disappointment.

The nucleus itself is a composite system, made

* Leaving out of account a few radioactive elements that have been artificially produced.

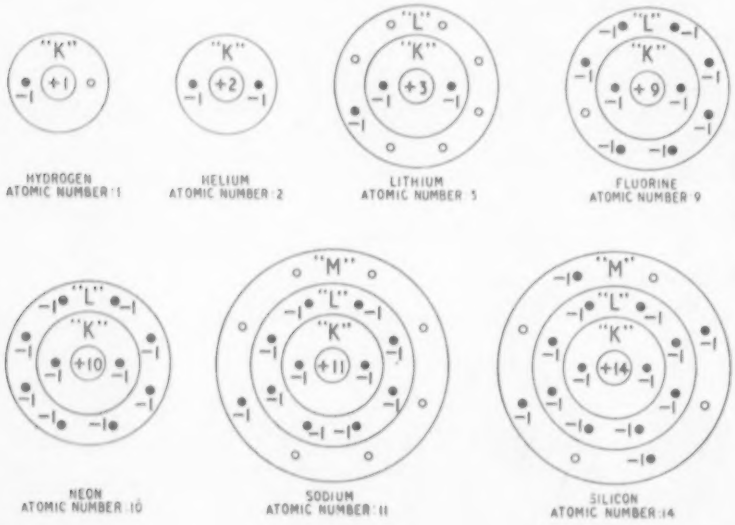


Fig. 1. Electric charge diagrams of atoms of a few of the chemical elements. Each black dot represents an electron, which carries one unit of negative charge (— 1). The nucleus at the centre carries a positive charge equal to the atomic number of the element. So a neutral atom must have the same number of electrons. These are distributed in "shells" known as "K", "L", "M", etc., each of which has a certain maximum capacity.

Fig. 2

Fig. 3

Fig. 2. For some purposes the atom diagrams can be greatly simplified by lumping the filled shells in with the nucleus and showing only the net electric charge inside a circle. Each of the electrons left over—the valency electrons—is represented by a minus sign. The diagram here replaces the sodium diagram in Fig. 1 and also a number of even more complicated ones.

Fig. 3. Atom diagram of the Fig. 2 type for certain elements including silicon and germanium.

up of neutrons and protons; but since we are not concerned just now with atomic energy ("nucleonics") we can ignore that and regard the nucleus simply as a single body, contributing most of the weight, and carrying a positive electric charge. Element No. 1 on the list (which is hydrogen) has a nucleus with one unit of positive charge; No. 2 (helium) has two units; No. 3 (lithium) three units; and so on. No. 8 is oxygen; No. 29, copper; No. 47, silver; No. 92, uranium. There are no fractions of a unit. And how much is a unit? It is equal and opposite to the negative charge of one electron.

So to make one neutral (i.e., uncharged) hydrogen atom it is necessary to cancel the positive charge, by adding to its nucleus one electron. And so on, all through the list; the number of electrons surrounding the nucleus of any element is the same as the number of that element in the list. It is called, not unnaturally, its atomic number.

Now although the modern picture of how these electrons are distributed around the nucleus is rather hazy, it is known that there are quite strict rules about it. They can exist only in certain "shells" around the nucleus, and the normal capacity of each of these shells is fixed. To change the analogy, an atom is rather like a restaurant with a number of tables of different sizes, in which the customers are made to fill all the seats at the first table, then the second, and so on. The first table, which is labelled "K", seats only two, and is fully occupied by helium with its two electrons. The second table ("L") seats eight, so the first two tables are completely filled in atom No. 10, which is neon.

Atoms of the great majority of elements, however, have one table only partly filled. In the lithium atom, one of its three electrons is obliged to sit all by himself at the second table. He resents this arrangement and is constantly watching for an opportunity to slip across to some other restaurant where there is a vacancy. Such a restaurant might be a fluorine atom, which with its nine electrons has one place unfilled at the second table—see Fig. 1. If the two different atoms come close together this transfer is almost inevitable. The fluorine atom, having gained an electron, is now negatively charged to the extent of one unit $(+9-10=-1)$; while the lithium atom is left with one of its three positive charges unneutralized $(+3-2=+1)$ so as a whole has one positive charge. These two atoms, being oppositely charged, are mutually attracted and enter into partnership under the new name of lithium fluoride. And so we have what is called a chemical reaction between two elements to form a compound, which is usually very unlike either. Incidentally, an amalgamation of two or more atoms is called a molecule.

An oxygen atom with its eight electrons has two vacancies at its second table, so is able to invite two hydrogen atoms with their single electron each to enter into partnership, forming H_2O—water. The number of vacancies or surpluses is called in chemistry the *valency*; in hydrogen and lithium and fluorine it is one, but in oxygen it is two. The valency of atoms such as helium and neon in which there are no partly filled tables is zero; they are extremely self-satisfied and stand-offish and cannot be persuaded to take an interest in any other atom. In other words, they form no chemical compounds.

The odd electrons in other elements, which do tend to enter into external relationships, are called valency electrons. For our present purpose we can greatly simplify our pictures of atoms by lumping in with the nucleus all electrons in filled shells, because they play no active role. This augmented nucleus is the main body of the atom, the only other components being the valency electrons, if any. In this simplified plan, 10 of the 11 electrons in a sodium atom can be included with the nucleus to form a body having an electrical charge $+11-10=+1$, surrounded and neutralized by its solitary valency electron, as in Fig. 2. The same diagram would do for copper or silver or gold, which all have one odd electron per atom (though the number of socially happy electrons within the circle varies according to the element; in a gold atom there are 78).

Shared Electrons

It is no accident that all the elements just mentioned are particularly good conductors of electricity. The "odd man out" belonging to each atom, having no close social ties, readily breaks away and roams around at random, hoping to find a vacancy. In a piece of more or less pure metal its chances are negligible; and so there is a vast army of unemployed (about 10^{23} per cu cm), easily persuaded by the influence of an electric field to drift along in a particular direction. This drift is an electric current. And if there is a large current per volt we say the resistance is low (or the conductance is high).

Atoms that possess at least half a shell-full of valency electrons have another method of satisfying their social instincts. Fluorine, for example, has seven out of eight; and if there is no atom present such as sodium from which it can get the one electron needed to make up the set it enters into partnership with another fluorine atom, on the basis that each atom shall regard one of its valency electrons as common to both. So each has seven of its own plus a shared one. The link between the two atoms via the shared pair of electrons is called a *co-valent bond*. Fluorine, then, normally exists in separate molecules each made up of a pair of atoms.

Silicon, also shown in Fig. 1, and germanium, have only half enough valency electrons to make a set of eight, so their atoms can be represented in the simplified manner as in Fig. 3. To make up the set, each electron has to link up with one of the four in another atom. If conditions allow this tendency to be fully realized, the result is a three-

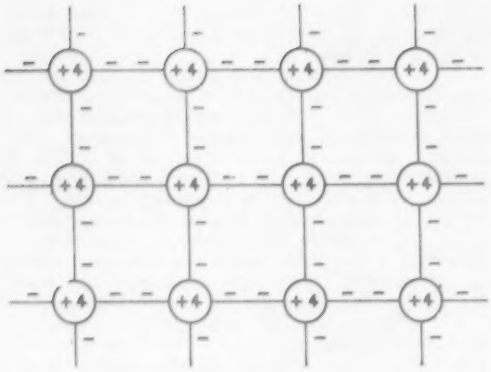
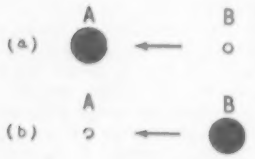


Fig. 4. The valency electrons in Fig. 3 tend to link up with others, as indicated in this diagram of a minute portion of perfect germanium crystal.



Left: Fig. 5. The movement of an electron from A in (a) to B in (b) can alternatively be regarded as the movement of a hole from B to A. The direction of the field causing the movement is in either case indicated conventionally by the arrow.

dimensional structure of the kind we all know as a crystal. A three-dimensional structure is awkward to show as a diagram on paper, but in this case it can easily be flattened out into two as shown in Fig. 4. The fact that all the valency electrons are occupied in maintaining co-valent bonds between atoms is indicated by the lines joining them together.

Shaking up Process

In a perfect crystal all the valency electrons would be fully occupied in this public-spirited service and there would be no loose characters open to the influence of every field. In other words, the crystal would be a perfect insulator. In actual fact, crystals of silicon and (still more) germanium are very far from being perfect insulators, but—as I have already indicated—exactly how far is difficult to determine, because attempts to measure their conductivity yield widely different results, for no very obvious reason. However, several reasons have been found.

One of them is that incoming energy such as heat or light can "shake out" a valency electron here and there. The process can be visualized by means of a model consisting of a perfectly flat level board like a billiard table, on which large numbers of small balls representing the valency electrons are mounted in regular formation. They are held in this formation by resting in shallow depressions or holes. Applying an e.m.f. between the ends of the crystal to produce an electric field throughout it is represented by lifting the end of the board that stands for the negative terminal. Provided that the tilt is only slight, it is not enough to get the balls out of their holes, so there is no current. This is like the crystal at absolute zero temperature.

The effect of raising the temperature of the crystal is simulated by shaking the board with increasing vigour. At a certain intensity a few of the balls begin to shake loose, even when the board is perfectly level. The vibration makes the loose balls wander about, and on a level surface their movements are completely random. In the course of this wandering, a ball is quite likely to come across an unoccupied hole, into which it will drop and stay until again it is shaken loose. The hole it drops into is not necessarily the one it originally filled. If the degree of board-shaking is kept constant, a balance is reached between the rate of shaking loose and the rate of dropping in or "recombination," so that the average number of loose balls remains practically constant. The greater the shake, the greater this number.

Now without leaving off shaking the board, apply a small e.m.f. by slightly tilting it. The random wandering of the loose balls is modified by a steady drift to the lower or "positive" end. There is a current of electrons through the crystal from negative to positive. To complete the analogy of the e.m.f. it is necessary to collect the balls as they arrive at the bottom end and transfer them to the top. The whole thing is now just the sort of picture one has of current through a metal, except that in the crystal only a minute proportion of the total electrons is loose, so the current is comparatively small. In other words, the conductivity of the material is low.

If we shake our model more vigorously, to represent a higher temperature, the proportion of loose balls is increased, and the current for a given tilt is greater. This represents the quite steep increase in conductivity of a semi-conductor when its temperature is raised. A metal, by contrast, has no more electrons to be loosed, so its conductivity does not rise; in fact, it falls slightly, because the vibration of the atoms impedes the current somewhat.

There is another difference between a metal and a semi-conductor. Nearly all the atoms in a semi-conductor are electrically neutral. But exceptionally there is the atom from which an electron has been shaken loose and is therefore a unit positive charge. Such atoms are represented in our model by the deserted holes on the board. In a semi-conductor the shortage of an electron is actually called a hole. Because the atoms, represented by the circles in Fig. 4, are fixtures—the very structure of the crystal, in fact—these positive charges or holes are fixed. Or are they?

When we were shaking our board we noticed that when an electron broke loose from a hole (say A in Fig. 5) it sometimes fell into another (B). Seeing that electrons and holes have no individuality but are all identical, the net result of such an incident could alternatively be described as the movement of a hole from B to A. But why describe it in this upside-down way, even if it does amount to the same thing?

The reason the electron moved to B rather than the opposite way may have been because there was an electric field in the direction of the arrow. Its movement from A to B was a tiny electric current, *against* the arrow because an electron is a *negative* charge. The same current is caused by an equal positive charge, *with* the arrow, from B to A. Referring to the incident as a movement of a hole does at least

(*Continued on page* 321)

"BELLING LEE" NOTES

Emley Moor

The following statement has been issued by the Independent Television Authority and is reproduced here with their permission: "The transmissions of low power test signals will begin next July from the site of the Independent Television Authority's second northern transmitter at Emley Moor, Yorkshire. These low power signals will be put out from the mobile transmitter which was originally designed, built and operated by Belling & Lee, Ltd., aerial manufacturers, and which has now been acquired by the Authority. This mobile transmitter was used for pilot test transmissions from the London, Lichfield, and Winter Hill sites, and it was found that in most cases very little adjustment to sets was subsequently necessary when high power transmissions began.

"As on previous occasions, the transmitter will operate at an effective radiated power of 1 Kilowatt, and with an aerial height of approximately 90ft."

The transmitter is at present at Enfield for the necessary modifications; it will lose its identity as G9AED, and presumably will become known as the I.T.A. test transmitter. "Belling-Lee" have made full use of the many reports that have come in, and will still take a very keen interest in its performance.

Shortly after the opening of the Emley Moor test transmitter, "Belling-Lee" will conduct a lecture tour of Leeds, Sheffield and Hull, and members of the trade will be invited. If readers who feel that they qualify and who have not received an invitation care to write to us at Enfield, we will see if we can accommodate them.

"Belling-Lee"

The correct title of this company is Belling & Lee Ltd. The short title "Belling-Lee" is a registered trade mark and where used it would be appreciated if the quotes were inserted.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield
Middx.
Written 30th May, 1956

A BALANCED PICTURE

—at the turn of a switch!

Very few receivers have sufficient latitude of control to enable the user to balance the B.B.C. and I.T.A. pictures so that the viewer may switch from one to the other without further adjustment.

The most satisfactory way to achieve this is by the judicious use of aerials and attenuators. What viewers need—and what you can give them—is a balanced picture with the minimum of adjustment. Always specify and install "Belling-Lee" aerials and attenuators for complete satisfaction and trouble-free service.

"Belling-Lee" supply aerials, attenuators, plugs and sockets, diplexers and interference filters, all of which contribute towards an efficient installation.

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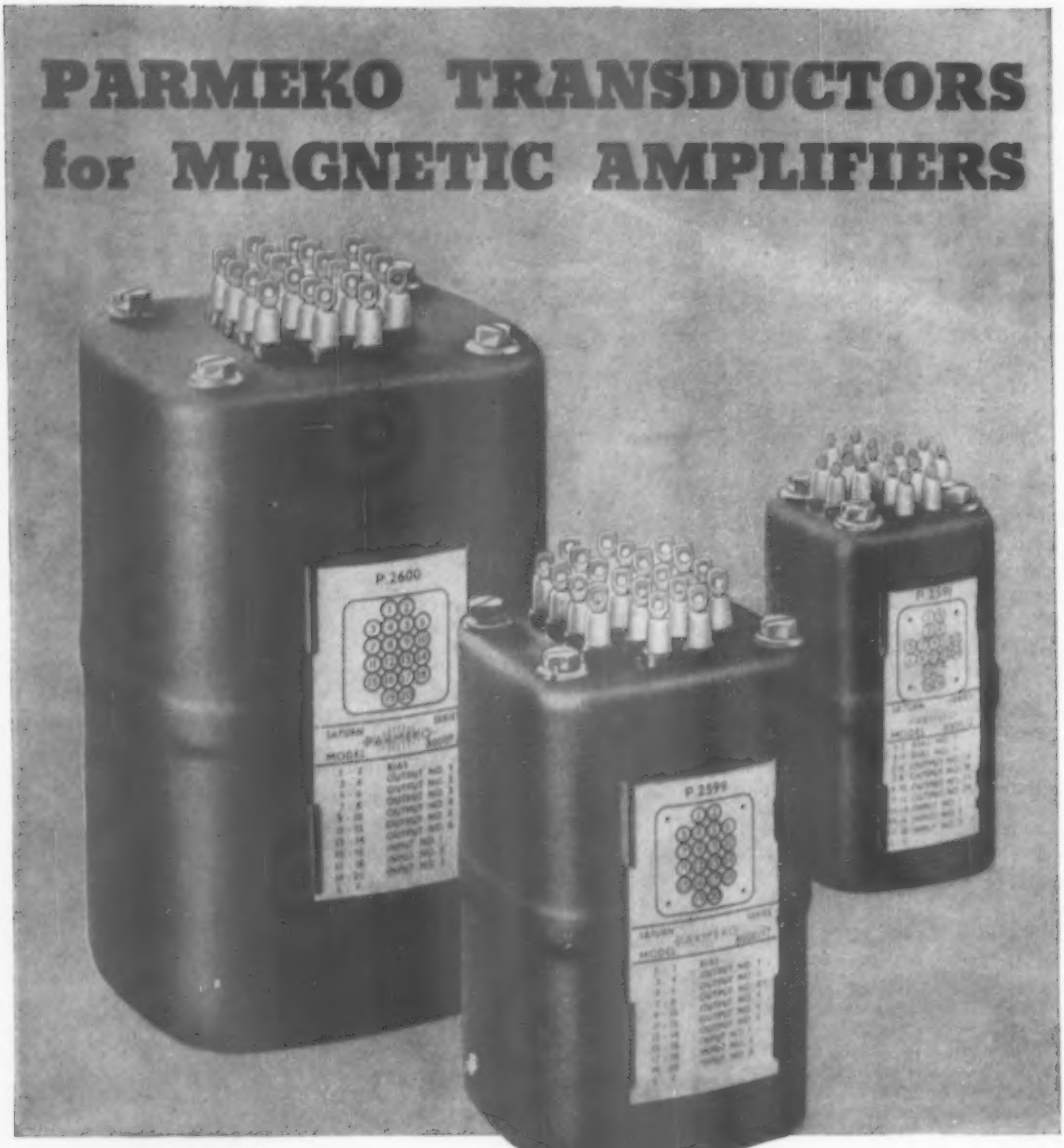
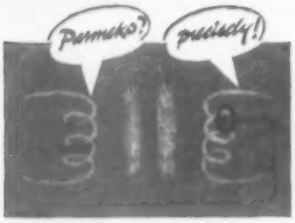
PARMEKO TRANSDUCTORS for MAGNETIC AMPLIFIERS





There are 14 standard types in the Parmeko 'Saturn' series of transductors for operation at supply frequencies of 400~and 1600~; and some for 50~. They are used in overload protection devices and servo-motor amplifiers, voltage and frequency regulators and high speed sensitive relays, high power gain amplifiers and D.C. amplifiers giving a linear output from 0 to 10 microamperes, and other industrial and Service equipment. Illustrated leaflet 854-2 gives complete specifications

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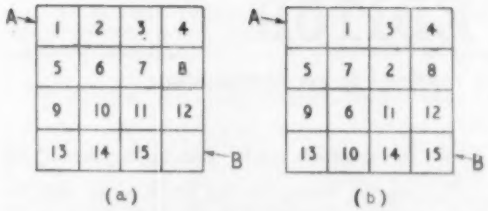


Fig. 6. This puzzle game shows more clearly than Fig. 5 the advantages gained by substituting hole movement for electron movement.

look more sensible as regards conventional signs. But we are so used to thinking of movements of electrons as conventionally positive electric currents going the other way that this alone wouldn't be sufficient reason for a little white lie.

The real reason appears if we remember that holes in semi-conductors are comparatively rare features of the material structure. Instead of Fig. 5 let us take up one of those puzzle games in which there are 15 movable square counters in a frame with room for 16, as in Fig. 6. Because there is only one vacant space or hole, the counters—representing electrons—can move only one space at a time. A considerable amount of shuffling is required to transform situation (a) into (b), and it would be excessively tedious to specify the individual movements of all the counters. It is much easier to say "Move the hole from B to A."

In the same way, instead of noting that under the influence of a certain electric field a vast number of electrons made very small journeys of various distances and directions, and having to add them all up, it is simpler to observe that the net result was the same as if one hole travelled the whole length of the crystal.

There is a point to watch. In Fig. 5 the electrical result could be stated as one electron transferred from A to B, *or* one hole from B to A. In Fig. 6 the result could be stated as the sum of a lot of short counter movements in various directions *or* as one hole movement from B to A. But in semi-conductors one generally has both. If an electron becomes detached somewhere in the middle of a crystal it may be moved by a field from there to the positive end; and simultaneously, by means of innumerable short electron shufflings, the hole it left behind may "move" from there to the negative end. The total electrical effect is actually the one long electron movement plus the innumerable short ones roughly in the same direction, but it can more conveniently be regarded as the one long electron movement plus the one long hole movement in the opposite direction.

That is an example of what I meant earlier in saying that relatively complicated actions, such as all the movements of counters from Fig. 6(a) to (b), can be replaced for convenience of description by simpler equivalent but not literally true actions, such as the movement of one hole, provided that the real meaning behind the simplified expression is understood.

You may be wondering why holes are not mentioned in connection with conduction in metals. The reason is that because all the atoms are *permanent* vacancies there is no sense in which they can be said to move. The term "hole" is reserved fo. a vacancy that appears to be mobile, which can only happen when vacancies can be re-filled by electrons.

So far, we have a picture that fits some of the experimental facts; namely, the conductivities of silicon and germanium, which are much greater than insulators but much less than metals, and rise rapidly with temperature. But that is only the beginning and will have to be continued in our next.

CRYSTAL PALACE COVERAGE

ESTIMATED coverage of the new London television station, showing the 100 μV/m contour obtained with the present temporary aerial (giving 60 kW e.r.p.) in relation to the same contour of the old Alexandra Palace transmitter. Also shown are estimated contours for the station when the permanent aerial is in use next year (giving 200 kW e.r.p.). In August this year it is expected that an intermediate temporary aerial will be mounted part of the distance up the permanent mast, giving an e.r.p. of 120 kW and slightly improving the present coverage.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Why 625 Lines?

I FEEL that I cannot let your editorial in the April issue of *Wireless World* pass without comment.

The position surely is that by sticking to our 405-line system we are the "odd man out," not only in Europe but, I believe, in the world. I am told by many most competent technicians that any compatible system which continues to use 405 lines for a colour picture may, in the long run, be unacceptable to the public. The introduction of colour television surely presents us with our last opportunity of coming into line.

I must also strongly disagree with your conclusions about the export market. Here is a great new field opening up before us and, if we stick to the 405 system, we will deliberately price ourselves out of it. To keep our products competitive it is essential that our export goods are developed from our home market. It is most unlikely that manufacturers in this country will be able to produce economically television receivers operating on a system different from that used at home because this would entail running two completely different assembly lines. Western Germany, for instance, using the 625-line system is able to export its home model with no modifications whatsoever and at prices considerably below those at which British manufacturers can afford to sell. Why then should we put ourselves even further behind our competitors in the export market by duplicating our plant to cover two different systems.

We cannot divide the electronics industry into watertight compartments. We must be able to make a profit from the export of television receivers if we are effectively to develop the other branches of the industry.

London, W.1. ROBERT RENWICK.

I READ with interest your editorial, in reference to Sir Robert Renwick's statement at the opening of the recent Components Exhibition.

Sir Robert's belief that "the B.B.C. are developing a system which can only be manufactured for the home market, thus making the cost of manufacturing sets for export on 625 lines quite prohibitive" can be re-quoted by the old adage, "A healthy home market means a healthy export market." If there is no home market for 625-line receivers, there is no export market.

The editorial uses the term "economic" as does the referenced article on p. 173, but I would suggest that the economic aspect inferred by Sir Robert Renwick should not be confused with the technical economics.

Unfortunately the editorial only refers to 625-line and in that connection your second paragraph may be true, but is the United Kingdom only interested in sterling markets? The 525-line, 60-cycle system, which is the equivalent of the 625-line, 50-cycle system, opens the dollar market and here in Canada the general impression is that the U.K. is short of dollars, not sterling.

Canada provides, under British Preferential Tariff, very favourable trading conditions whereby radio apparatus, including components, can enter Canada duty free. Importation of complete receivers is restricted by the Canadian Radio Patents, Limited, but assemblies such as television multi-channel tuners, e.h.t. horizontal scan transformers, deflection assemblies, i.f. strips, printed circuit assemblies, etc., etc., can be imported without restriction. However, unless development engineering and production costs can be amortized across home production as is the case with U.S. components imported into Canada, then the cost of such components landed in Canada will be non-competitive.

Most of the above paragraph applies to Canada, but equally effective cases can be made out for other dollar countries.

The question whether or not 625 is better than 405 is of secondary importance to the issue raised by Sir Robert Renwick for Britain to adopt a system which will enable her to compete in the world's electronics markets.

W. JONES.

Pye Canada, Ltd.,
Toronto.

Flywheel Sync

IN the May issue, R. Williamson writes about the "highly desirable" feature of line flywheel synchronization.

As an engineer with a local firm, I too am often asked by prospective buyers for advice in choosing a receiver.

The first thing I do is ask the customer where he lives, and provided the signal strength in his area is good and free from external noise, I recommend the receiver which I consider is most *reliable* and which, from a serviceman's point of view, is the easiest and most accessible to maintain.

I would say that under normal conditions of reception, the most desirable feature is the use of automatic picture control, by whatever name one likes to call it.

I say this because too often I find that when I have to pay service calls, the average member of the public seems to have great difficulty in correctly setting the contrast control for optimum picture response, and the use of a.p.c. generally removes the need for any adjustment of contrast once it has been correctly set, even when the B.B.C. have to reduce power.

On the other hand, if reception conditions are poor, and line tearing is likely to mar the picture, I fully agree that flywheel sync is essential, but in my humble opinion, it is sheer waste of valve circuitry, and needlessly adds to the cost and complexity of a receiver when signal conditions are such that it is not necessary.

I really *would* like some set designers to work at our bench for a month—and handle their particular products—I'll wager they'd have removable bottom covers and easy-fit knobs, etc., or frayed tempers!

Hafod, Swansea. TREVOR G. HUGHES.

I NOTE in your May issue that R. Williamson is surprised that television dealers appear to dislike flywheel synchronization, and do not encourage customers to choose a set with this feature.

As a television retail manager, may I offer a possible explanation. I have no knowledge of fringe areas, and can well believe that under conditions of very low field strength this type of circuit may have advantages.

For normal areas this circuit seems to introduce a new set of problems; among which are: phasing difficulties, temperature drift, and, from the user viewpoint, the difficulty of setting the line-hold control to "mid-point." It is also undesirable that the line-hold control can be used as a form of picture positioning adjustment!

I am mystified by the increasing complexity of line-hold circuits and wonder if these are really necessary. More than two years ago a quite low-priced receiver made by one of the largest manufacturers had no line-hold control at all. This set performed very well and held line synchronization down to the lowest level at which a picture was visible. This circuit proved quite reliable; even after conversion to multi-channel recep-

tion, the line lock remaining superior to many more complex circuits now in use.

Harrow, Middx. M. A. SALTER.

"*Television Receiver Input Impedance*"

WE were surprised to see no mention of the use of the Smith Chart in J. E. Hopkins' article on the above subject in the May issue. Whilst admitting that the formulæ given are correct, the arithmetic involved in obtaining even a single impedance is tedious and that required to cover a frequency band is out of all proportion, particularly if an admittance bridge is used and series-parallel conversions are required. By employment of the Smith Chart, all the necessary calculations can be carried out with only one setting of the slide rule (provided that admittance is measured as G+jB and not G+C) and the impedance read directly from the chart with any type of bridge.

The method used by the writers is briefly as follows: The electrical length of a short length of cable is obtained by open- or short-circuit measurements. This cable is then connected to the receiver and the admittance measured of the cable and receiver combined, the result being plotted on the Smith Chart. The length of the cable can then be allowed for by rotation of the plotted point through an angle corresponding to the measured electrical length. This gives the admittance of the receiver alone and the impedance can be obtained by a further 180° rotation. For a frequency run the cable length is measured at a few frequencies and a graph drawn to enable lengths at intermediate frequencies to be read off.

We feel that this method is extremely simple and much quicker and less liable to error than any arithmetical-algebraic method. Also, the accuracy obtainable on the Smith Chart is certainly as great as that of the measurement itself.

G. C. THOMPSON.

London, E.13. P. A. J. LOVATT.

"*Two-channel Stereophonic Sound Systems*"

IN the article by F. H. Brittain and D. M. Leakey, in your May issue, it is stated that "the reproduced sound image is more accurately positioned if arrival time differences are overruled and the sound is positioned by intensity differences only."

In the system described, in which the sound is reproduced by a pair of loudspeakers ten feet or so from the observer, it is difficult to see, since each loudspeaker communicates with both ears, how amplitude differences at the loudspeakers can produce intensity differences at the ears, except at frequencies above, say, 1 kc/s when the observer's head becomes an appreciable obstacle.

What, in fact, does happen when spaced loudspeakers reproduce identical sounds at different amplitudes is that the contributions at each ear from the two loudspeakers add vectorially to produce a resultant time difference, owing to the different path lengths from either speaker to each ear. This happens best at frequencies for which such path differences are small compared with a wavelength of the sound emitted; at higher frequencies, ambiguities arise. This part of the frequency spectrum, however, includes the region of maximum radiated energy for most sounds.

The authors rightly state that low frequencies are of importance, but it is to be feared that the requirements they lay down for the loudspeaker polar diagrams are difficult to meet in this region.

Furthermore, I must join issue with them regarding their requirements concerning microphone polar diagrams for "correct positioning of the sound images." Without delving too far into details, it seems clear that, when the sound image is to occupy the position of one of the reproducing loudspeakers, the other loudspeaker should be substantially silent. This calls for a null in the polar diagram of one of the microphones in a direction corresponding to such a position of the source in the transmitting studio. The authors' diagrams, however, show a level difference at the microphones of only 12 dB. Clearly, something is wrong, as this level difference is inadequate to produce the effect of sound from one loudspeaker only.

In fact, if ribbon microphones are used with their axes inclined at 90°, theory indicates that reasonably correct reproduction is achieved for movements of the source within the whole of this angle. In this context, "correct" implies proportionality between the angular displacement of the source in the studio and angular displacement of the reproduced image.

P. B. VANDERLYN.

E.M.I. Research Laboratories,
Hayes, Middx.

IN their article in the May issue, Brittain and Leakey show that if two non-directional loudspeakers are used to reproduce the component channels of a stereophonic signal, then correct "placing" of the resultant image signal will be obtained only by an observer listening from a point on the line normal to and bisecting that joining the two loudspeakers. This is what anyone would expect who has ever experimented with two speakers in a room; Brittain and Leakey go further, and by evaluating the image movement produced by unbalance, show that compensation for this effect holding good for various listening positions simultaneously can be introduced by using loudspeakers having a specified radiation characteristic which is markedly directional.

The line of reasoning of this article appears unassailable, and one is therefore extremely puzzled by the opposite statement of Martin & Smith on p. 218 of the same issue, dealing with the E.M.I. "Stereosonic" system, that "The polar diagram of the loudspeakers should ideally be as nearly semi-circular in the horizontal plane as possible." Will the writers please support this statement in the light of the claim made by E.M.I. that the stereophonic effect of their system is *not* limited to a central listening position.

For the undersigned at least, the E.M.I. system is not successful unless a central listening position is chosen. From any other position, the effect is not markedly superior to that of quasi-stereophony obtained by feeding a single channel through two separated and different loudspeakers. The main body of sound appears to emanate from the nearer speaker, with a "background" of sound covering the area bounded by the two speakers and occasional disconcerting splashes of sound from the more distant one.

Some explanation also seems called for why tone controls have been considered necessary in the "Stereosonic" reproducer. Tone controls are still a regrettable necessity, for reasons now perfectly well understood, in a single-channel system where all is compromise and the studio engineer can hope at best only to represent, not present, a certain listening environment, but in a system whose essential function is to present a *realistic* sound picture which includes the size and the environment of the source, it would seem axiomatic that any deviation from a level overall response can introduce only deterioration.

London, N.10. IAN LESLIE.

Recorded Programmes

IF it is not too personal a question, does the Editor fill the opening page by ringing up the printer and saying the first thing that comes into his head? I see no virtue in spontaneity other than a means of creating that "life and soul of the party" atmosphere so much enjoyed by regular listeners to "My Wildest Dream." In all performances involving artistic creation, recording affords the opportunity of making several attempts before broadcasting the best.

Hindhead, Surrey. HENRY MORGAN.

Ferroresonant Computing Circuits

New Techniques for Switching and Counting

By R. S. ARBON* AND G. PHYLIP-JONES,* Ph.D.

THE increasing use and complexity of modern electronic digital computers and telephone switching systems has given rise to a demand for reliable new types of devices to replace thermionic valves, which statistics show are the least reliable elements in a modern computing machine.

Among the various devices introduced one of the most promising depends on the use of essentially non-linear magnetic phenomena, involving the use of new magnetic materials having rectangular hysteresis loops and low loss. The magnetic devices may be of two forms, either static or dynamic. The former is characterized by the absence of a power supply, high speed of operation (up to 10^6 counts per second), indefinitely long retention of information, long life and small dimensions. The disadvantages are the difficulties involved in sensing the information in the core ("0" or "1") without disturbing it and the fact that voltages read out are often unsuitable for direct driving of following stages. Since the elements are passive, they often need the aid of additional amplifying devices of less reliability. Finally the current required to switch the state of the cores is generally considerable and increases as the counting rate is increased.

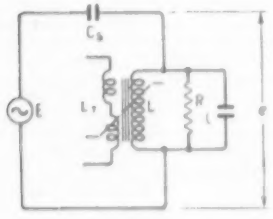


Fig. 1. Basic ferroresonant circuit.

The dynamic magnetic devices on the other hand continuously draw power from an a.c. supply during operation (e.g. magnetic amplifiers), but this supply can be common to many elements. Less well known than the magnetic amplifier, but of great importance in switching applications, is the dynamic bistable magnetic device which makes use of another kind of instability in the steady state response of non-linear circuits—the so-called ferroresonant effect. This device is characterized by the use of an a.c. power supply, medium speed of operation (up to 5×10^4 counts per second), indefinitely long life and small dimensions. The information stored is retained for as long as the a.c. power supply is maintained but will be lost if the supply is momentarily interrupted. The devices have the advantage that they are energy-amplifying, permitting direct interconnection of consecutive stages without the necessity of additional amplifiers. In addition, output voltage or current is continuously available, permitting easy read-out or switching of additional stages. Finally power drawn from the a.c. supply can be very small, being as little as 30mW per stage in the "on" condition ("1") and negligible in the "off" condition ("0"), while the trigger current requirements are very modest, since only a few milliamperes can be sufficient to switch the state of the device.

Ferroresonance is a phenomenon well known to the electrical power engineer and has often in the past proved to be of considerable nuisance to him.

The phenomenon is typified by instabilities in circuits containing capacitors and saturable iron inductors and can cause heavy currents in transformers at power frequencies. This occurs when, say, the alternating voltage across the inductor momentarily increases so that the inductance decreases from a normal high value to a lower, saturated value. If the inductor is connected in a circuit containing capacitance of a value which resonates with this lower value of inductance, the increased current drawn from the supply may be sufficient to maintain the inductor in this saturated state even after the initial voltage surge has ceased. This current might be so large as to permanently damage, or even destroy, the inductor or transformer.

The circuit then has two possible states. One is characterized by the normal value of inductance and current, the other by a much larger current and lower value of inductance than before. For the second state to be stable, the inductance must decrease sufficiently for the increased current to maintain it at this value. It will be apparent therefore that actual resonance is not necessary for the two stable states to be achieved, although, of course, the nearer resonance the circuit is, the larger will be the current flowing.

With the advent of high-permeability, low-loss magnetic materials, it is now possible to utilize the principle of ferroresonance at frequencies much higher than power frequencies and fulfil a requirement for a switching circuit with switching rates intermediate between circuits using cold-cathode tubes and thermionic valve circuits.

Analysis of Basic Circuit

In the basic ferroresonant circuit the non-linear inductor L and capacitor C can be connected as either a series or a parallel circuit, the most suitable form being used for any particular application.

Considering the parallel case in Fig. 1, the LC circuit is supplied from the generator E by the capacitor C_b and the losses associated with the parallel circuit are represented by R. The value of C_b is chosen so that the current drawn from the supply is approximately constant irrespective of the state of the LC circuit, thus permitting many stages to be fed from the same generator. The inductance L may be changed from an unsaturated high value to a saturated low value by means of a control current through the auxiliary winding L_T, and C is chosen to have a value that will nearly resonate with the lower value of inductance L. In the circuit the only

* General Electric Company.

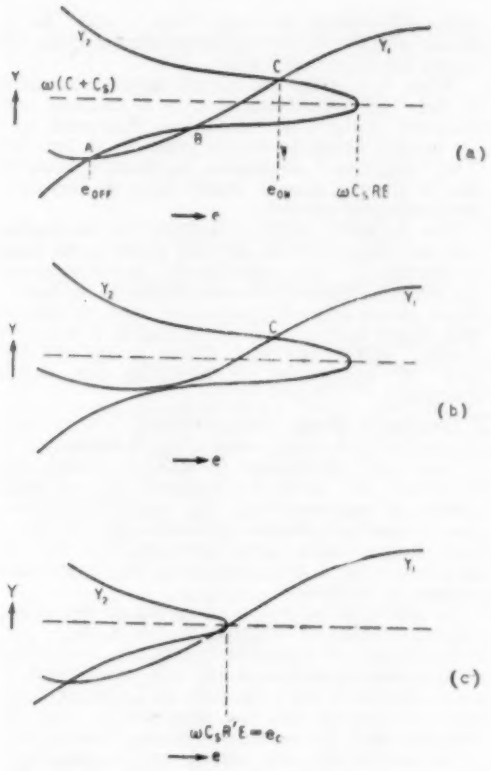


Fig. 2. Graphical representation of circuit action.

components which vary with supply voltage are L and R, and it is possible to measure their variations experimentally if only the fundamental frequency is considered.

Mathematical analysis of the circuit is difficult because of the non-linear elements involved, but the circuit action can be clearly explained by means of graphical analysis. From Fig. 1 it can be established that

$$\frac{1}{\omega L} = \omega(C + C_s) \pm \omega C_s \sqrt{\left(\frac{E}{e}\right)^2 - \left(\frac{1}{\omega C_s R}\right)^2} \quad (1)$$

Both sides of this equation are functions of the voltage (e) across the coil and can be plotted graphically as shown in Fig. 2(a), using the previously determined values of the coil parameters. Curve Y_1 represents the left-hand side of the equation ($1/\omega L$) and curve Y_2 the right-hand side. The two curves intersect at three points, A, B and C, which give the solutions of the equation (that is, $Y_1 = Y_2$). Point A corresponds to the stable "off" condition of the circuit where the coil is in the high inductance state, and the output voltage is low (e_{OFF}). Point B is unstable, while point C corresponds to the stable "on" condition where the coil is in the low inductance state and the output voltage is large (e_{OS}). The peak of the Y_2 curve is obtained when

$$\sqrt{\left(\frac{E}{e}\right)^2 - \left(\frac{1}{\omega C_s R}\right)^2} = 0 \quad \text{i.e. when} \quad e = \omega C_s RE.$$

To switch from the "off" to the "on" state, a small d.c. current must momentarily be allowed to flow through the trigger winding so that the Y_1 curve becomes as shown in Fig. 2(b), where the two curves only intersect at the point C, corresponding to the "on" condition. The effect of a resistive load connected across the circuit LC is to displace the Y_2 curve to the left, as shown in Fig. 2(c). When the load is such that the peak of the Y_2 curve just intersects the Y_1 curve, the voltage across the circuit is given by $e_c = \omega C_s R'E$ where $R' = \frac{R \times R_{LOAD}}{R + R_{LOAD}}$. With a further small increase in loading, the two curves will not intersect and the circuit can no longer be maintained in the "on" condition. In practice, however, these two values of load resistance are vitually identical.

Two Modes of Operation

It will be apparent from the foregoing that while the basic circuit can be switched from the "off" to the "on" condition by trigger current due to an external signal through the control winding L_T (Fig. 1), switching off can only be effected by variation of one or more of the circuit parameters (e.g. by damping the circuit LC due to an external load), or by reduction of the r.f. supply voltage. This corresponds to branch P in Fig. 3 which shows the relationship between voltage e across the inductor and the current i_b through the trigger winding for a fixed supply voltage E. It will be seen that with the stage initially off, a trigger bias current $i_b = I_{b1}$ is sufficient to turn the stage "on" and that subsequent reduction of the trigger current to zero still leaves the stage in the "on" condition. It will be seen, however, that if the trigger current is increased to $i_b = I_{b2}$, another region of instability is reached, branch Q, which possesses the property

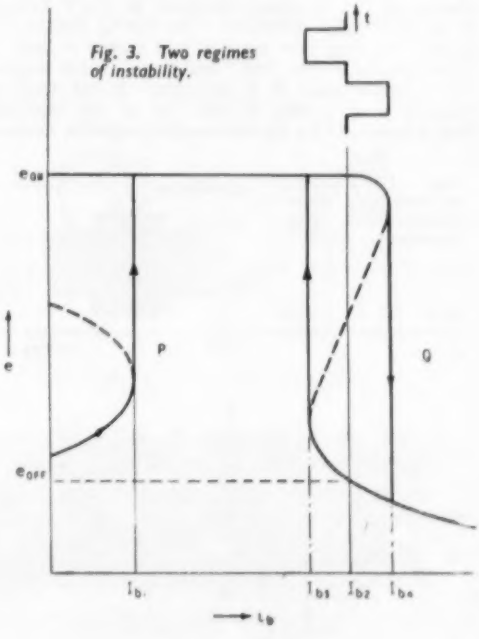


Fig. 3. Two regimes of instability.

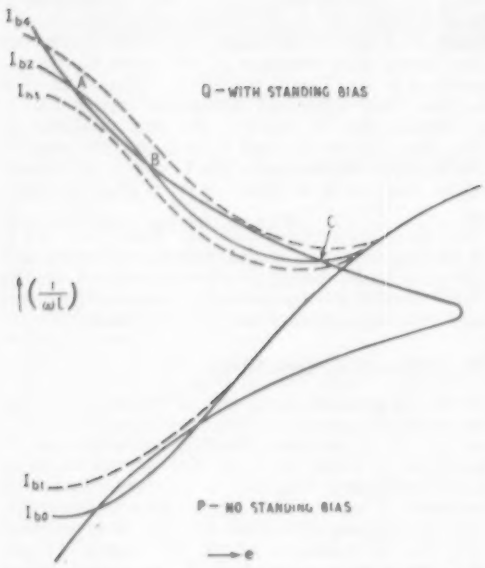


Fig. 4. Graphical representation of two operating modes.

that the "off" or "on" states can be obtained by increase or decrease of trigger current respectively.

Supposing the stage is in the "on" condition, then a positive current pulse superimposed on the standing bias current I_{b3} will switch the stage to the "off" condition. Similarly, a negative current pulse will switch from the "off" to the "on" condition. The two modes of operation are clearly shown in Fig. 4 where operation in the P branch is as previously described. In the Q branch I_{b2} is the standing bias current and points A and C represent the stable "off" and "on" states respectively, while point B is unstable. If the stage is initially "off", then a reduction of the standing bias current to I_{b3} by means of a negative current pulse will switch the stage "on", while an increase of I_{b2} to I_{b4} by a positive current pulse will switch the stage "off" again.

When $I_b = 0$ the LC circuit appears capacitive in the "off" condition and, in a practical case, inductive in the "on" condition, while with $I_b = I_{b3}$ the LC circuit is usually inductive in both the "off" and "on" conditions. In all cases, however, due to C_s, the current drawn from the supply is predominantly capacitive.

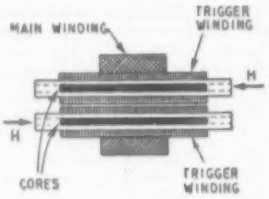
The foregoing graphical analysis for the parallel case can be applied equally well to the series mode by putting $C = 0$ in equation (1). It will be apparent therefore that this bistable device in its various forms (series or parallel operation, with or without bias trigger current) can be utilized as a computer element, and a later part of this article will deal with the applications to switching and logical functions.

Design of Basic Unit.—Metallic core material possessing high initial permeability is necessary for ferroresonant applications in order to ensure that saturation can easily be achieved with a small number of ampere-turns. The material must also have a nearly rectangular hysteresis loop so that a large change in incremental permeability (and hence inductance) for a small change in the magnetizing current is obtained.

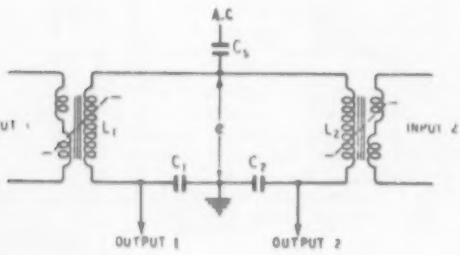
In order not to waste r.f. power in the trigger circuit, a balanced winding, in which the e.m.fs induced from the main winding into the two halves of the trigger winding cancel each other, must be used. Although this is possible with a single ferromagnetic core it has the disadvantage that the magnetic fields due to the two halves of the winding are in opposition and hence try to magnetize the core in different directions. It is therefore better to use two cores with one half of the trigger wound on each as shown in Fig. 5, so that the control current saturates each core separately and reduces the effective permeability of each to a low value. The choice of the number of turns depends on the trigger sensitivity required and the optimum arrangement is to make the length of winding the same as the length of core material.

In order to minimize the power consumption of the unit in the "on" condition, it is necessary to have as high a dynamic impedance for the LC circuit as possible, consistent with reliable operation at a low output voltage, while to permit reasonable variation between various units, there is a minimum permissible value for $\Delta\left(\frac{1}{\omega L}\right)$, the change in susceptance over the working range.

Right: Fig. 5. Construction of a ferroresonant unit with double core.



Below: Fig. 6. Simple ferroresonant flip-flop circuit.



The main winding can be (1) layer wound, (2) several wavewound pies, or (3) a single wavewound pie. The second and third methods yield higher dynamic impedances than layer wound coils and for minimum variations and ease of manufacture the third method using Litz or stranded wire is the most satisfactory. In practice it has been found that the best configuration for the coil is when the length is slightly less than twice the diameter.

Computing Applications.—A simple flip-flop circuit due to Isborn is shown in Fig. 6, and consists of two non-linear inductors L_1, L_2, in series with capacitors C_1, C_2 respectively, the combination being in series with a capacitor C_s. The reactance of C_s has been chosen such that one and only one

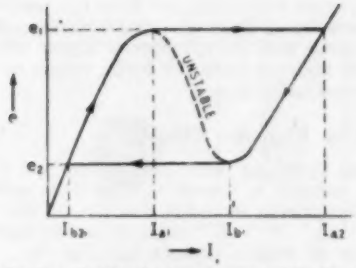


Fig. 7. Graphical representation of flip-flop action.

of the two branches can be in the "on" or high-current state ("1"). If both branches should be in the "off" or low-current state ("0"), the voltage e would rise to such a value that one or other of the two branches would be forced "on." Alternatively, if both branches were in the "on" state, the voltage e would fall to such a low value due to the increased voltage drop across C_s that either L_1C_1 or L_2C_2 would be forced to the "off" state.

Fig. 7, showing the action for either branch, can also be considered representative of the flip-flop as a whole, since at any instant only one stage can be "on" or "off." From this figure, giving the relation between r.m.s. values of voltage e and current I through one branch, it will be seen that when e is increased from a low value onwards, at a critical voltage $e=e_1$ a sudden jump in the response current occurs from I_{a1} to I_{a2}. In this new situation the response is again stable unless the voltage e becomes smaller than the second critical value $e = e_2$ where a transition from the high current state I_{b1} to the low current state I_{b2} takes place.

Switching is effected by passing a current pulse through the trigger winding associated with the branch in the "off" condition, thus switching this branch "on" and the other "off." The device then has a counterpart in thermionic valve circuitry, having two inputs and two outputs (in anti-phase), with a constant current drawn from the supply. If a single input flip-flop is desired, inputs 1 and 2 of Fig. 6 can be tied together and pulsed simultaneously; successive trigger pulses will then cause the flip-flop to change its state. The whole action takes place in a period equal to about 5 cycles of the supply frequency. Coupling between stages is obtained by rectification and differentiation of the output of one stage to form a trigger pulse for the input of the next stage.

The flip-flop circuit just described can be readily adapted to ring counters with as many elements as desired. Since only one stage will be "on" at any instant, the same principles apply and by connecting the appropriate number of stages in a ring any desired submultiple of an input pulse stream can be obtained.

A shift register consists of a series of identical bistable stages each of which contains a binary digit ("0", "1"). The digital information can be brought into the register either in parallel to all sections at the same time or in serial form at the beginning of the register. The application of a shifting pulse shifts the information-pattern one place along the register. At the end of the register the information is re-obtained serially after a time depending upon the number of intermediate sections used and the repetition rate of the shifting pulses. The register can therefore be considered as a delay line with a pulse-controlled delay.

Shift Register Operation

Fig. 8 shows three consecutive stages of a typical shift register, while Fig. 9 is a photograph of a 28-stage register constructed on a 19-in × 1¾-in rack panel. This register operates by using the instability in branch P, Fig. 3, and the operation is as follows.

Consider stage (1) "on" and stages (2) and (3) "off." The peak voltage across stage (1) is 25 volts (e_{ON}), while the peak voltage across stages (2) and (3) is 5 volts (e_{OFF}), see Fig. 2(a). In the absence of a shift pulse, then, the shift line will be at −30 volts and none of the diodes will conduct. This condition will hold until the arrival of a shift pulse, which raises the shift line up to zero potential. Diode D_1 will then conduct on the negative half-cycle of voltage across stage (1), charging C_T,

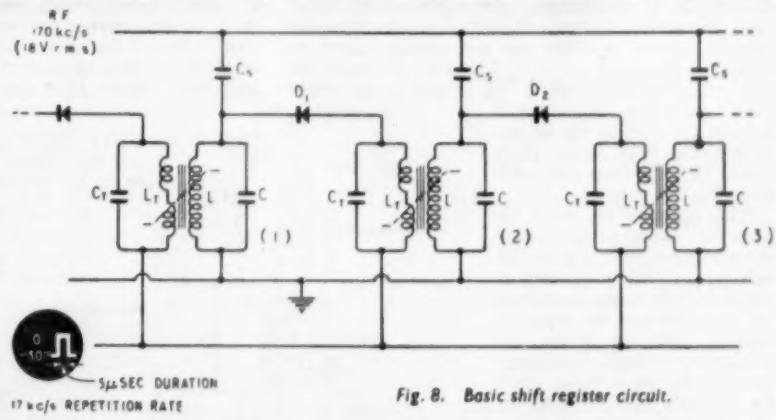


Fig. 8. Basic shift register circuit.

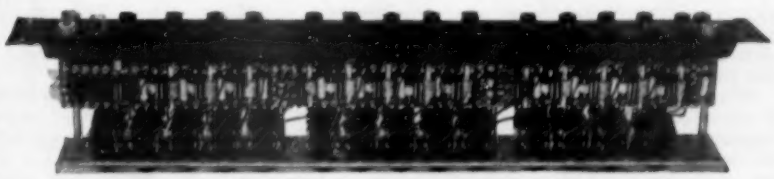


Fig. 9. Construction of a 28-stage shift register.

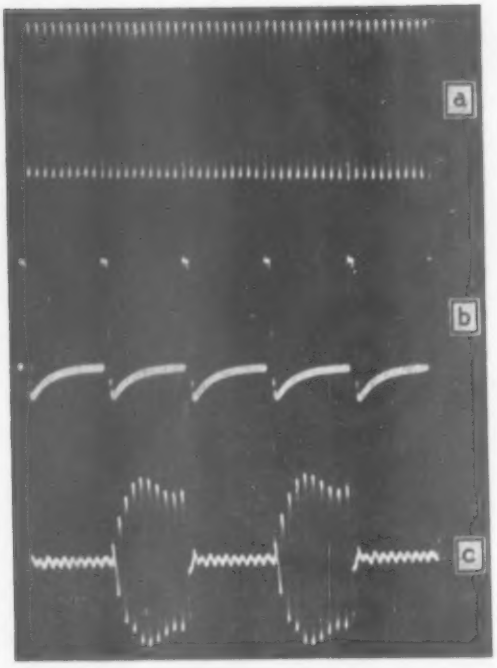


Fig. 10. Shift register oscillograms: (a) stage "on," no shift pulse, (b) shift pulse, (c) 1 "on," 1 "off" pattern.

and in so doing stage (1) is switched to the "off" condition due to the voltage e falling below the critical value (e_c), Fig. 2(c). The discharge of C_T through L_T is sufficient to switch stage (2) "on" after the shift pulse has ceased, since the resultant trigger current modifies the susceptance curve to such an extent that point C, Fig. 2(b), becomes the only point of intersection. Since this is the stable "on" condition, stage (2) will remain "on" until the arrival of the next shift pulse, when stage (2) will be turned "off" and stage (3) "on."

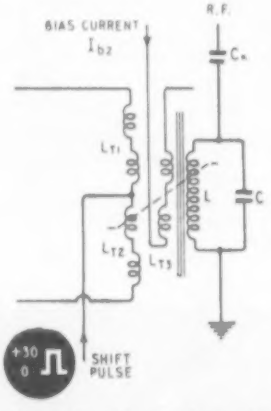
The value of C_T must be such that it will provide sufficient damping to reduce the voltage (e_{OH}) below the critical value (e_c) in order to switch off, while it will be apparent that in order to obtain the maximum available switching energy, the shift pulse must be critically phased with respect to (e_{ON}). Fig. 10 shows typical oscillograph waveforms in the "off" and "on" conditions, together with the relative phasing of the shift pulse.

When additional circuits are required to be operated by a register stage they can either be connected direct to the output with some reduction in permissible variation of supply voltage E, or via buffer stages. With this method it is only necessary to insert the trigger winding of the buffer in series with the appropriate trigger winding in the shift register, using the buffer output to feed the additional circuits.

Alternative Register Circuit

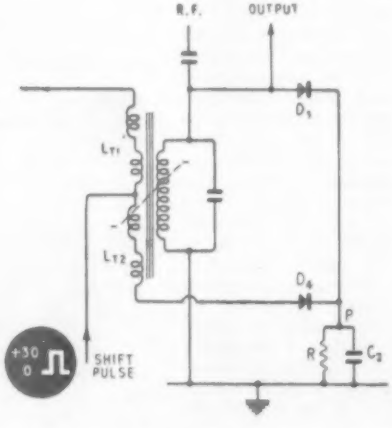
A different operating mode can be obtained if the instability existing in branch Q (Fig. 3) is utilized, since in this regime the basic unit can be switched to either "on" or "off" states by either decrease or increase of trigger current I_{b2} (Fig. 4). The fundamental circuit is shown in Fig. 11 and has in addition to C_s, L and C, three windings, L_{T1}, L_{T2}, L_{T3}, each balanced to r.f. Winding L_{T3} is a bias winding which is connected in series with all bias windings of other stages and through which a standing current I_{b2} is passed (Fig. 4). The winding sense of L_{T1} is such that a positive current pulse through it will aid the standing bias, while L_{T2} is in the opposite sense, i.e., a positive current pulse through L_{T2} will oppose the standing bias. If a current pulse of value $(I_{b4}-I_{b2})$ (Fig. 3) is applied through L_{T1} the stage will be switched "off," while if the same pulse is applied instead through L_{T2}, the stage will be switched "on." If the same current pulse is applied through L_{T1} and L_{T2} simultaneously, however, their net effect is nil and the stage is undisturbed.

In Fig. 12 is shown the basic stage used for both register and logic circuits, where it will be seen that diodes D_3 and D_4, capacitor C_2 and resistor R have been added to the circuit of Fig. 11. The output of the stage is rectified by D_3 and gives a high or low positive voltage at P according to whether the stage is in the "on" or "off" condition. Resistor R forms a discharge path for capacitor C_2, the time constant C_2R being chosen to be somewhat less than the period between successive shift pulses. When the shift pulse appears, therefore, if the stage was "off" P will be at +2V, diode D_4 will conduct, current will flow through L_{T2} and the stage will be switched "on." If a similar current is simultan-



Above: Fig. 11. Fundamental circuit using instability in branch Q.

Fig. 12. Ferroresonant stage used for register and logic circuits. (The bias winding shown in Fig. 11 is omitted here for clarity.)



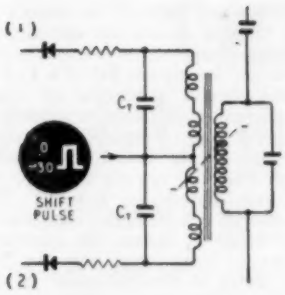


Fig. 13. Circuit of Boolean Adder or OR gate.

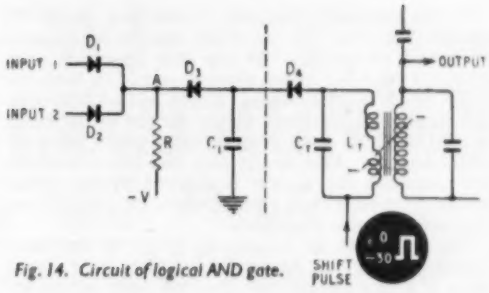
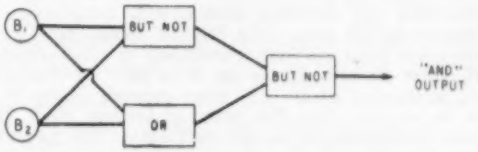


Fig. 14. Circuit of logical AND gate.

Fig. 15. Alternative arrangement for obtaining logical AND gate.



eously passed through L_{T1}, however, the stage will be left in the "off" condition. If the stage was previously "on," P will be at +30V, no current will flow through L_{T2} and the stage will remain on. Current through L_{T1} however would again switch the stage to the "off" condition. It will be apparent therefore that L_{T1} can be used as a control winding, since every time current is permitted to flow through it, the stage is switched "off."

Logic Circuits.—The logic circuits to be described are divided into two groups: (a) those operating in branch P, Fig. 3 (i.e., without bias current), and (b) those operating in branch Q, Fig. 3 (with bias current). The former group will be described first. Each logic circuit is considered as having two input terminals for connection to the outputs of any two stages, but for the purposes of description an input is only deemed to be present when fed from a stage in the "on" condition.

The OR gate or Boolean Adder is the simplest logic circuit, since it is required to give an output when either one or both inputs are present. Fig. 13 shows a method of obtaining the OR gate, where the two inputs are fed to separate trigger windings.

The BUT NOT gate is required to give an output when one input only is present, all other conditions giving no output. This requirement is met by using the same arrangement as for the OR circuit (Fig. 13) with the exception that the effective winding direction of one of the triggers is reversed with respect to the other. This means that there will be an output when either input is present, but with two simultaneous inputs the two magnetizing fields cancel and there is no output. To obtain an INVERTER it is only necessary to feed one of the two trigger circuits from a d.c. source with the signal applied to the other.

The AND gate is required to give an output only when both inputs are present and this can be provided by either using a diode gate feeding a subsequent basic stage as shown in Fig. 14, or by a combination of BUT NOT and OR circuits as shown in Fig. 15. The diode gate (to left of dotted line) operates as follows. Assuming diodes D_1 and D_2 non-conducting, C_1 is charged negatively from V through R and the forward impedance of the diode D_3. When the next shift pulse arrives D_4 conducts and C_1 is discharged through the trigger circuit (C_TL_T) of the basic stage. If either input (1) or (2) is in the off condition, however, the appropriate diode (D_1 or D_2) conducts and holds point A effectively at earth, and C_1 does not charge. Assuming both inputs "on," C_1 is permitted to charge to the peak value of the negative half-cycle of the input signal, while on positive cycles of the input point A follows the input and D_3 does not conduct.

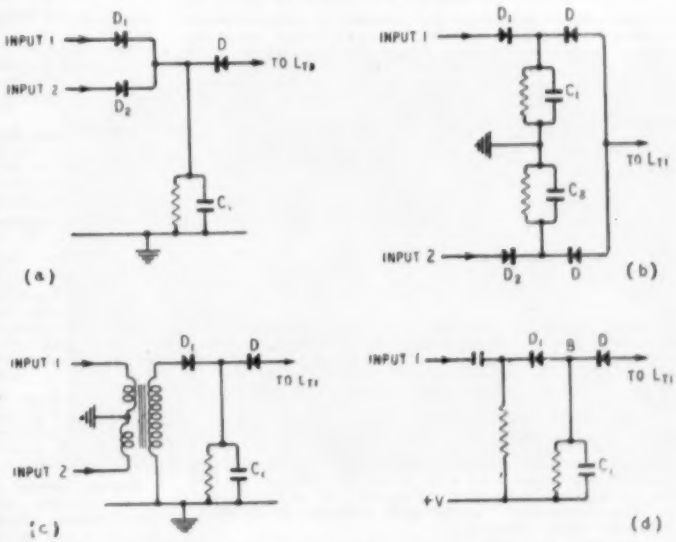


Fig. 16. Logic circuits for branch Q operation. (The actual ferroresonant stages are omitted for the sake of clarity.)

In the alternative method of obtaining the AND circuit (See Fig. 15) the AND answer is obtained after two operations. In the first operation each input (B_1 and B_2) is fed simultaneously to both the BUT NOT and OR stage. In the second operation the outputs of these two stages are fed to the input of a BUT NOT stage, the output of which gives the AND answer. Due to the fact that two operations are necessary, the answer is delayed by the period of two successive shift pulses instead of one as in the previous circuits described.

For operation in branch Q (Fig. 3) the basic circuit (Fig. 12) can be used to perform logic operations if it is arranged that the two logic inputs are combined so as to control the current through L_{T1} in the required manner.

In Fig. 16 (a), a Boolean Adder, the circuit of the basic stage, as previously described, is not shown, but only the circuitry necessary to convert this stage to an OR gate. The INPUT 1 and INPUT 2 are taken from the output terminals of other stages. If either or both inputs are from an "on" stage, C_1 is charged up to +30 volts through diodes D_1 or D_2 or both, and this potential inhibits diode D from conducting during the shift pulse. No current will flow through L_{T1}, therefore, and the stage will not be switched "off." If neither input is present however, diode D conducts during the shift pulse and the current through L_{T1} will switch the stage "off." The requirement for an output when either or both inputs are present is then satisfied.

The additional circuitry for an AND gate is shown in Fig. 16 (b), where unless both diodes D are inhibited, shift pulse current will flow through L_{T1} and switch the stage "off." Since the diodes D will only inhibit when both C_1 and C_2 are fed from "on" stages, the requirement is met for an output only when both of the inputs are present.

In Fig. 16(c) is shown the circuitry necessary to precede a basic stage to convert it into a BUT NOT gate. The two inputs are fed to a 1 : 1 transformer with double-wound primaries of opposite sense and of sufficient inductance to present a negligible load on either input. Accordingly an output from the secondary of the transformer (and hence inhibition of diode D) is only available when either, but not both, inputs are present. The requirement for the BUT NOT gate is then satisfied.

In Fig. 16(d) is shown the circuitry necessary to convert the basic stage into an INVERTER. When no input is present, point B is sufficiently positive (due to bias voltage V) to prevent diode D conducting when the shift pulse is present. No current can then flow through L_{T1} to switch the stage "off." When there is an input however, C_1 is charged negatively with respect to +V through the diode D_1 such that the voltage at point B becomes approximately zero. When a shift pulse arrives, therefore, diode D will conduct and current flows through L_{T1}, switching the stage "off." The output therefore will be the inverse of the input signal.

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COMMERCIAL LITERATURE

Interference Suppressors (for inclusion in mains leads of appliances) covering l.w., m.w., s.w., and Band-I television. Also **Television Interference Filters** (for inclusion in aerial feeders of sets): Type E5031, Band I only, eliminates 70 Mc/s and above; Type E5037, Bands I and III, eliminates 40 Mc/s and below; Type E5038, Bands I and III, eliminates 40 Mc/s and below and also 70-170 Mc/s. Leaflets from Labgear, Willow Place, Cambridge.

Portable Record Player with 4-speed auto-changer (including 16 r.p.m.) and turnover crystal pickup with permanent sapphire needles. Notable for cabinet moulded in one piece from resin-bonded wood laminate, claimed to give improved reproduction. Leaflet from Fidelity Radio, 11-13, Blechynden Street, London, W.11.

"**Variac**" voltage-regulating transformers. A price list and abridged catalogue, giving basic data on all types available, from Claude Lyons, Valley Works, 4-10, Ware Road, Hoddesdon, Herts.

Unit-Construction Cabinets, telescopic mountings and cabinet fittings. Illustrated catalogues with detailed drawings showing the dimensions and construction of components in the various gauges. From Hallam, Sleigh and Cheston (Widney Dorlec), Oldfield Road, Maidenhead, Berks.

Three-Phase Transformers of improved construction with cores of cold-rolled grain-oriented silicon steel, permitting higher flux density and giving higher efficiency for given weight and volume. Smaller types hermetically sealed and oil-filled and larger ones with open-type construction and normal impregnation. Max. rating 2.5 kVA at 50 c/s; star or delta connections. Leaflet from Parmeko, Percy Road, Aylestone Park, Leicester.

Audio Transistor Circuits using junction types OC70, OC71 and OC72. An RC-coupled hearing-aid; a transformer-coupled hearing-aid; an earthed-base preamplifier circuit; and a 200-mW a.f. amplifier with push-pull output, suitable for use with a crystal pickup or as a.f. stages of battery receiver. Leaflet from Mullard, Century House, Shaftesbury Avenue, London, W.C.2. Also a leaflet on a **Dual-Trace Oscilloscope** (Y amplifier 5 c/s - 4 Mc/s bandwidth), an oscilloscope 35-mm camera and an oscilloscope probe.

L.F. Variable Attenuator, reversible, with range of 0-70dB in 1dB steps; input and output impedance 600Ω. Errors negligible up to 200 kc/s and do not exceed 2.5dB at 1 Mc/s with high attenuation. Leaflet from Advance Components, Roebuck Road, Hainault, Essex.

Relays, Contactors and Counters; illustrated leaflet with data on type of energization, sensitivity, contact arrangement and size. From Relais Stomm, 55, Rue Hoche, Vanves (Seine), France.

AM/FM Receiver, 7-valve, 4-band, constructional details. A booklet with theoretical circuit, point-to-point wiring, chassis dimensions, photographs, and full alignment instructions for both a.m. and f.m. sections. From Weymouth Radio Manufacturing Co., Crescent Street, Weymouth, Dorset.

Terminal Lugs, through-type, suitable for use in various thicknesses of Paxolin. Ratings 10 and 15 amps. Abridged catalogue (containing also other types of terminals) and technical bulletin; available to the trade from Harwin Engineers, 101-105, Nibthwaite Road, Harrow, Middlesex.

Battery-Powered Record Playing Unit, for 7-in 45-r.p.m. discs. Current consumption averaging ¼ watt over useful life of battery. Standard model intended for 6-V dry battery but motor can be wound for anything up to 24 V. Crystal pickup (single stylus) or, for export, ceramic and magnetic types. Leaflet from Garrard Engineering and Manufacturing Co., Swindon, Wilts.

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Two-Channel Stereophonic Sound Systems

By F. H. BRITTAIN* and D. M. LEAKEY,* B.Sc.

2.—Details of the Methods Used in G.E.C. Demonstrations

IT was shown in the first part of this article (May issue, p. 206) that a two-channel stereophonic system should consist of two identical but separate channels, each separately fed from a suitably placed microphone and each feeding a separate loudspeaker. Directional microphones placed close together are to be preferred to pick up the sounds; and at the reproducing end the loudspeakers should have suitable directional properties to increase the area of satisfactory stereophonic listening. Complete separation of the two channels was envisaged, but, in a practical system, cross-connection between the channels may be used in order to achieve the desired characteristics.

Fig. 1 shows a block schematic diagram of a complete two-channel system with all the essential features included.

At the sound pick-up end of the chain the two microphones feed two separate but identical low-noise pre-amplifiers which bring the signals to a suitable level for switching and cross-connection, if required. This is followed by ganged fader controls and a balance control to equalize the channel gains. From the balancer two separate, but again identical, tape amplifiers feed the two recording heads which make two tracks on a single tape of normal width.

Monitoring facilities, usually in the form of a headset with the earpieces fed separately from the two channels, must be provided to balance the system. Separate visual level indicators for the two channels are also required. It is important to note, however, that when setting up the system only the channel receiving the louder sounds can be run at the maximum recording level, the level of the other channel being dictated by balance considerations.

For playing back the tape two separate heads feed two separate low-noise amplifiers equipped with the necessary post-recording equalizing networks. The signals then pass via the ganged faders and balance control to any tone controls which may be required, and from them to the power amplifiers feeding the loudspeakers.

Deviations from this outlined scheme are quite permissible, and in the G.E.C. system to be described, small variations will be found. Each item will be described in turn while working through the system. Most emphasis will be placed on the microphone and loudspeaker arrangements, since these items differ most from normal single-channel practice.

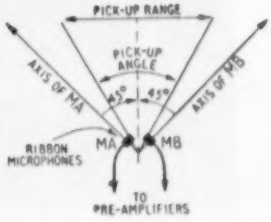


Fig. 2. Diagram showing 60° angle of sound pick-up for ribbon microphones mounted at 90° and not interconnected.

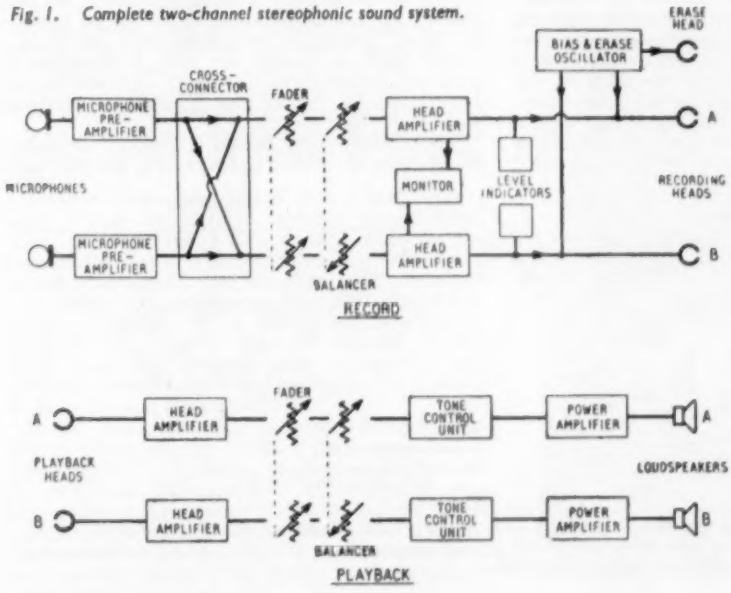


Fig. 1. Complete two-channel stereophonic sound system.

Sound Pick-up.—Two ribbon microphones with "figure of eight" polar response are used. They are placed as close together as possible to avoid time of arrival differences of the sound at the microphones and are set with their axes at 45° on either side of the recording centre line; as shown in Fig. 2. Fig. 3 shows a pair of G.E.C. "Senior" ribbon microphones, specially mounted, which

* Research Laboratories of the General Electric Co., Ltd., Wembley.

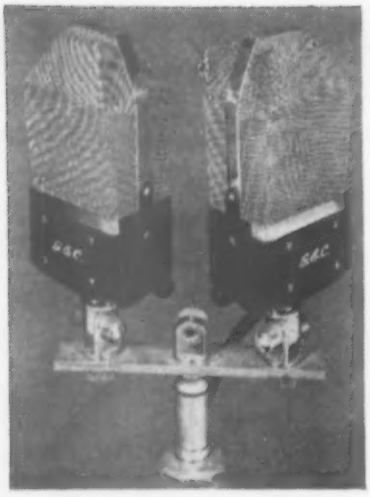


Fig. 3. G.E.C. "Senior" ribbon microphones mounted with their axes at 90°.

have the required frequency response and a polar distribution which is virtually independent of frequency up to 12 kc/s. The polar response of these microphones is shown in Fig. 4 and compared with the required curve which was given in the previous article and here shown dotted. It can be seen that, for the correct positioning of the virtual sound images at the receiving end of the system, the angle of pick-up is limited to about 60°. However, by cross-connection between the outputs of the microphones (after the preamplifiers) it is possible to obtain a good approximation to the required curve for a 90° angle of pick-up. This is illustrated in Fig. 5.

An obvious trouble arising from the use of ribbon microphones is the presence of a response from the rear of the microphones which picks up sounds which are reversed as regards right and left compared with the pick-up from the front of the microphones. At low frequencies this may help to pick up hall reverberation and position it, but at high frequencies it can lead to very undesirable muddle. To reduce this effect a thick quilt of cellulose wadding is suspended a short distance behind the microphones to reduce the high-frequency pick-up from the backs of the microphones.

Microphone Pre-amplifiers.—The microphones feed two identical low-noise, two-stage amplifiers of conventional design.

Cross-connector, Fader and Balancer.—The design of the cross-connector depends very much on the effect which is desired. For the purpose of increasing the pick-up angle to 90°, only a simple resistance mixer circuit is used.

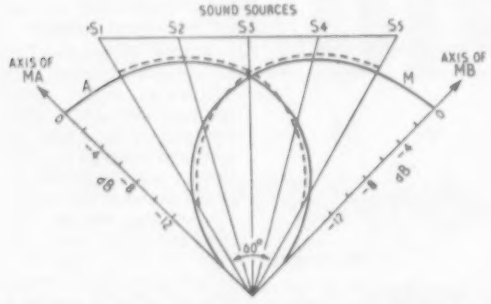
The fader consists of two ganged linear wire-wound potentiometers which were chosen because they stay accurately ganged at all settings, which is essential if the balance control is not to be operated every time that the gain is changed. The use of linear potentiometers meant that a signal level change of only about 20 dB could be handled. To overcome this trouble, separate logarithmic potentiometers were included in each channel. By their use both the overall gain and the balance could be controlled, leaving the ganged fader for fine control of the level.

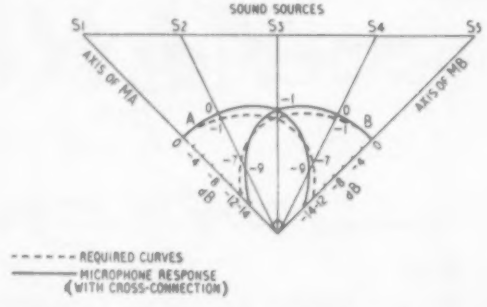
Tape Deck and Amplifiers.—Modified "Truvox" tape decks and amplifiers are used. The following modifications were made to the deck itself:

(1) The erase head was replaced by a second record/playback head operating on the second track. At the time of construction stacked heads were not generally available so that spaced heads had to be employed. The removal of the erase head meant that only "cleaned" tape could be used, but this was not found to be a serious difficulty. The alignment and spacing of the two heads had to be very accurately set so that tapes would be interchangeable on various machines.

(2) The tape speed was increased to 12 in/sec. This was done for three reasons: to improve the high-frequency response, to lessen the accuracy necessary in setting up the head spacing, and to ease editing. The mechanical accuracy necessary when setting up the heads is a direct function of the tape speed. At a tape speed of 7½ in/sec an error in the head spacing of ten-thousandths of an inch would result in an effective time displacement of about 1½ milliseconds. The speed of 12 in/sec was an arbitrary figure since only experimental machines were to be constructed.

The modifications to the "Truvox" amplifiers which were used both for recording and playback,



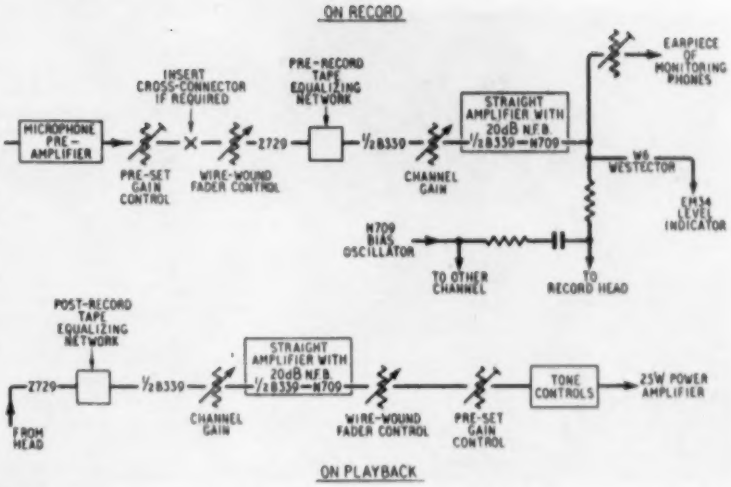


Left:—Fig. 4. Polar response of microphones compared with the ideal curve for 60° pick-up angle and (right) Fig. 5. Polar response of microphones with cross connection for 90° pick-up angle compared with ideal curve. Cross-connection signals (level —14dB) phased to add to straight-through signals.

with suitable switching of circuits, were made to improve, among other things, the frequency response below 50 c/s and to remove one oscillator from the pair of recording amplifiers. A schematic diagram of the modified circuits and a summary of the performance is given in Fig. 6, whilst Fig. 7 shows a photograph of one of these machines.

Playback Fader and Balancer.—The arrangement is similar to that used for recording.

Tone Control Units.—For simplicity in operation ganged tone controls should be used, but it was found that separate controls for each channel could be used, provided that they were fitted with calibrated scales so that pairs of controls could be kept at the same setting. Only simple treble and bass "boost" and "cut" controls are necessary, since any corrections for deficiencies in the system can be made permanent.



Above:—Fig. 6. Outline of circuit of tape amplifiers, one channel only. The other channel is identical. Overall frequency response (excluding microphone and loudspeaker), ±2dB, 30-12,000 c/s; signal/noise (for 2% total distortion recording level), unweighted 48dB, weighted 60dB.

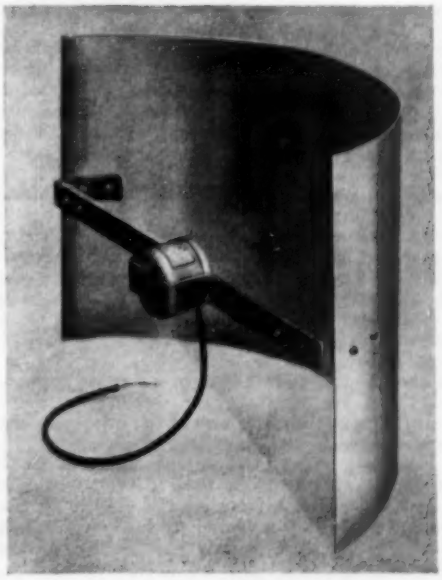
Left:—Fig. 7. Modified "Truvox" tape machine with duplicated amplifier circuits.

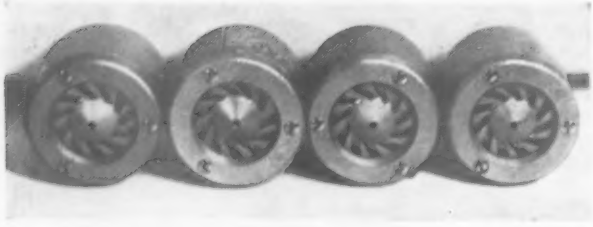
Below:—Fig. 8. Experimental treble reflector loudspeaker.

Power Amplifiers.—Standard 25-watt high-quality amplifiers employing the "ultra-linear" circuit are used.

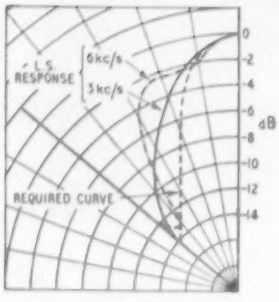
Loudspeakers.—The design of the loudspeakers is made very difficult, due to the particular directional characteristics which are required. It has been found that it is possible to obtain very satisfactory stereophonic reproduction even when the loudspeakers are non-directional below a frequency of about 1,000 c/s. They can in fact be a pair of standard "octagonal" cabinets housing G.E.C. Metal Cone loudspeakers; other loudspeakers and cabinets could be used if they approach this standard of quality in the bass.

In the treble, two main problems present themselves. First, how to obtain a polar curve which approximates to the required shape and maintains it over a range of frequencies. Secondly, to see that any of the devices which are used to obtain the required polar curve do not influence the frequency response of the system. A reflector-mounted pressure unit gave satisfactory results and is shown in





Above :—Fig. 9. Experimental treble miniature "line source" loudspeaker.



Left :—Fig. 10. Polar response curve of an experimental treble loudspeaker unit (not those shown in photographs).

Fig. 8. Fig. 9 shows a miniature "line source" loudspeaker consisting of four small high-frequency units; the line must be graded in intensity to give the required polar response at a frequency just in the working range of the units, and the effective length of the line must then be made proportional to the wavelength in order to maintain the polar response independent of frequency. Considerable difficulty will be experienced from unwanted "lobes"; these can be reduced by use of sound-absorbing screens.

It has been found in practice that normal domestic 8-in and 10-in loudspeakers are sufficiently directional at the higher frequencies to produce some correction for "off axis" listening. It is also possible that the new wide-range electrostatic loudspeakers now becoming available may have advantages, since they can be made with a "figure-of-eight" polar response, and it may prove possible to modify this shape to the curve actually required.

Loudspeaker Positions.—Fig. 11 shows a preferred listening arrangement, the loudspeakers being set at suitable angles to produce the required polar response along the front listening line. This usually requires that the loudspeakers be pointed towards the extreme listener at the opposite end of the front row of the audience as illustrated. The most serious trouble that can arise with such a system is usually due to reflections from the side walls of the room. It is sometimes necessary to hang curtains on the side walls where the loudspeakers are pointing at them.

Conclusions.—It is most necessary to point out that there are very definite limitations to two-channel systems; they represent the minimum additional apparatus that has to be employed in order to reproduce sounds with spatial separation. For example, they cannot be used if the loudspeaker spacing is very much more than 20 feet with a front listening line rather nearer than this distance. The reason for this is that it is not possible to compensate late arrival time by means of additional loudness for more than a few milliseconds. Also, with only two channels, it is not possible to change the apparent reverberation time of the listener's surroundings, or to reproduce sounds which should come from behind him. To do this additional channels must be used.

Since there are a number of compromises which have to be made in the design of any stereophonic system, it follows that there must be several, not one single, solutions to the problem. Many of the compromises of to-day will change with the knowledge of to-morrow and so we may expect to see many stages towards perfection.

It is perhaps more difficult to express the performance of a stereophonic system in figures which have any meaning to a normal reader than any other feature of sound reproduction. However, the system just described was given a searching test before an audience of some hundreds of people. The test was as follows. A particular piece of music played on a piano on the stage was recorded in the actual hall in which the demonstration was to be given. During the demonstration, the sound image of the recorded piano was superimposed on top of the actual piano. To check both the position and the quality of the reproduction, the piece was carefully rehearsed and the pianist, who kept time with the tape recording by means of an earphone, played some of the notes directly on the piano; other notes were played from the tape. In all there were 14 changes between the live piano and the stereophonic system in the space of four minutes and all but three went undetected by the audience who, in spite of looking straight at the piano from a short distance, were unable to detect the reproduced sound by change of position or quality.

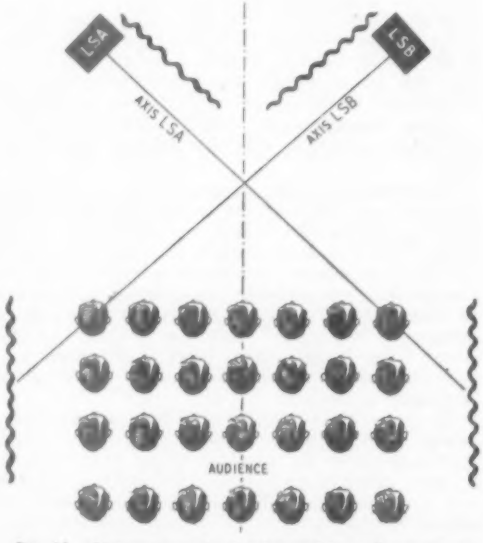
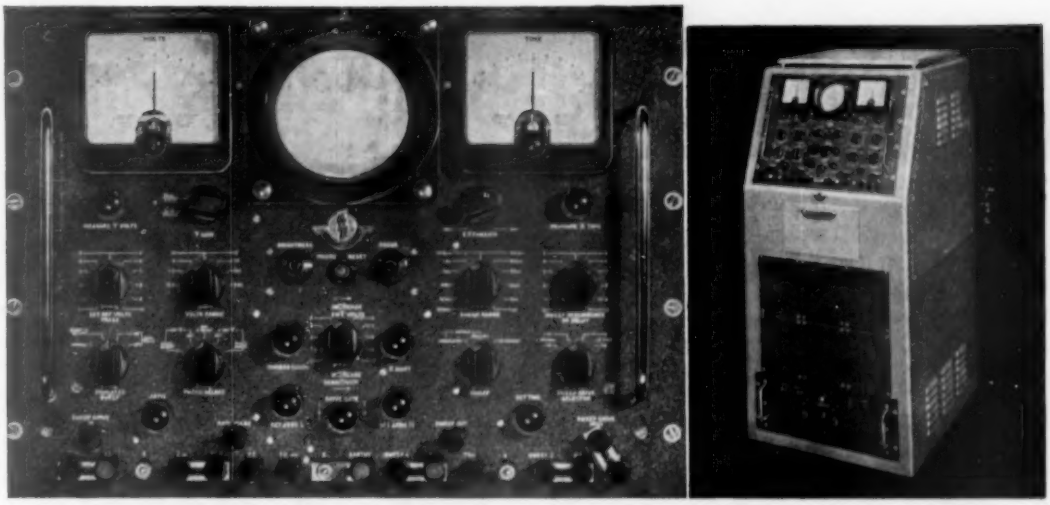


Fig. 11. Listening set-up, showing positions of curtaining to reduce the more undesirable reflections.



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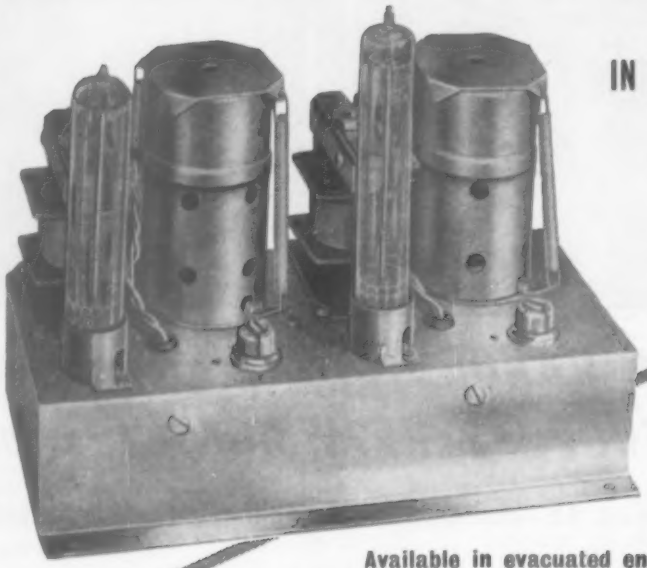

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DEVELOPMENTS IN

SOUND REPRODUCTION

New Equipment Shown at Recent Exhibitions

THIS year has been one of unprecedented activity in the field of sound reproduction and the number and variety of new amplifiers and associated equipment shown by manufacturers at the first London Audio Fair, the British Sound Recording Association's exhibition and the Radio Components Show reached a level which was matched only by the spread of interest in matters relating to high-quality sound among the general public.

It was noticeable that many manufacturers who have hitherto addressed themselves to the initiated few had gone out of their way to prepare literature explaining technicalities in a way which could be readily understood by the tyro.

Another significant trend was the increased number of "integrated" sound systems in which the various parts, although still available separately, are designed to match each other and provide a specified overall performance. For those who know what they want and how to get it there is still the possibility of building a system with pickup X, amplifier Y and loudspeaker Z, but newcomers are better served by being able to choose between the complete outfits now offered by manufacturers X, Y and Z.

Loudspeakers.—The constant-charge, push-pull electrostatic principle, which is capable of giving reproduction virtually free from harmonic distortion, is incorporated in new loudspeakers which were shown by Leak, Acoustical, and Goodmans.

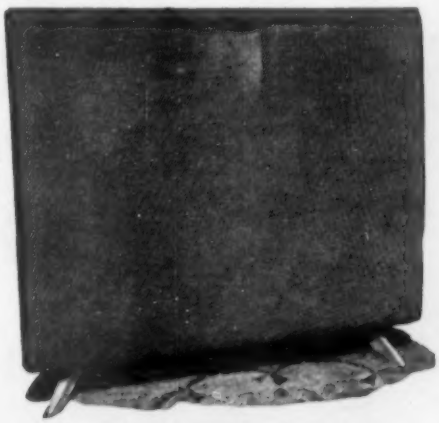
The Leak unit functions from 1000 c/s upwards and is used, in conjunction with a cross-over filter, with a moving-coil loudspeaker for lower frequencies.

In the Acoustical unit which measures 33in × 25in × 3in and resembles a fire screen the frequency range extends down to 50 c/s. A central medium- and high-frequency strip is flanked on both sides by low-frequency diaphragms and the mutual acoustical loading is arranged to give an integrated output on complex sounds. There is no cabinet or baffle, and the "figure-of-eight" radiation characteristic can be exploited to minimize the effects of room acoustics. It is stated that at maximum output a sound level of about 95 phons will be obtained in the average living room.

Development models of a full-frequency-range electrostatic loudspeaker were demonstrated by Goodmans, but no details of construction were disclosed.

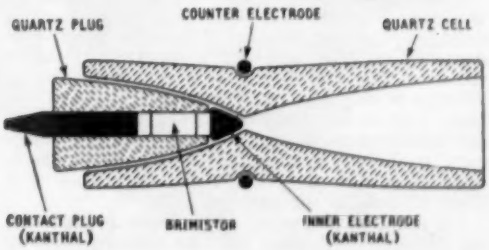
The "Ionophone" which converts electrical to sound energy through movement of the molecules in a region of ionized air has now reached the production stage in the Type D15 unit made by Plessey. It has been found possible to dispense with the rich positive ion source material, which in the original invention was used to coat the anode, and was somewhat variable in performance, and to use a stable refractory oxide material (kanthal) which does not "sputter" to form any coating on the walls of the quartz cell. The unit is horn loaded and covers frequencies from 2000c/s upwards.

Horn loading is employed in the Lowther TP1 reproducer which has a moving coil drive with a magnet flux density of more than 20,000 gauss and an electro-acoustic efficiency rated at 50 to 60%. Also horn loaded is a new high-frequency unit

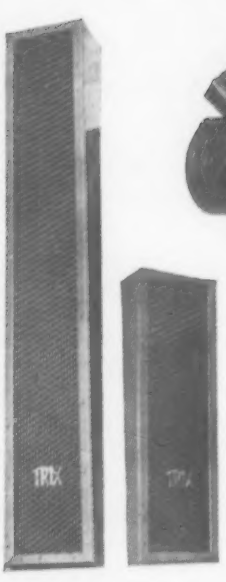


"Acoustical" constant-charge electrostatic loudspeaker.

Above:—Plessey "Ionophone" in production form.



Right:—Modified glow discharge cell ("Ionophone").



Above :— Trix "line source" column loudspeakers.

Whiteley 12in Duplex loudspeaker with "mid-frequency stabilizers."

Right :— G.E.C. metal-cone loudspeaker with new high-frequency insert unit.

introduced by Tannoy to meet a demand, primarily from America, for separate h.f. and l.f. sources. Normally, of course, a dual-concentric unit forms the basis of the Tannoy "G.R.F." and other enclosures.

To extend and improve the high-frequency range of the G.E.C. metal-cone loudspeaker a moving-coil h.f. unit has been developed which screws into the centre pole of the main magnet in place of the existing "bung" equalizer. It has a small metal diaphragm with a tangentially-slotted cover designed to give wide-angle dispersion at high frequencies. The response is stated to be within 2 dB of the level at 5 kc/s from 1.5 kc/s to 13.5 kc/s.

An extended frequency range is provided in a new dual unit introduced by Reproducers and Amplifiers in which a 5in "tweeter" is mounted concentrically with a 12in "woofer." The units make use of the R & A concentric principle of assembly and have phosphor bronze voice-coil leads integrally moulded with the bakelized linen centring-member.

Loudspeakers of 12in diameter and above in the Whiteley range are now fitted with "mid-frequency stabilizers" which consist of circular patches of damping material arranged to control subsidiary vibrations and improve the delayed response characteristics. A new 8in unit (Type DC816) with 16,000-gauss magnet has been introduced for the middle and high frequency range, and another new development is the introduction of tapped voice coils in some models to give alternative impedances of 3, 7.5 or 15 ohms in the same unit.

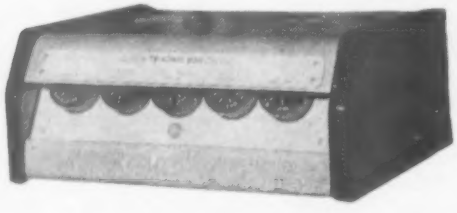
For use in miniaturized circuits with printed wiring, Plessey now make a 6in × 4in inverted elliptical speaker with a depth of only 1¼in. This can be supplied with a centre-tapped voice coil (30 to 100 ohms) for direct connection in transistor push-pull output circuits.

The design of baffles and enclosures is of equal importance to that of the loudspeaker, particularly at very low frequencies. In the "standard" Lockwood loudspeaker cabinet the principles outlined by D. E. L. Shorter (*Wireless World*, November and December, 1950) are followed, and a corner cabinet version demonstrated at the B.S.R.A. exhibition, had provision for three loudspeaker units.

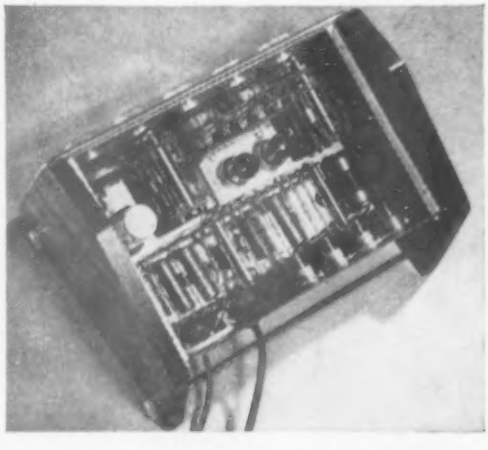
To reduce the cabinet volume Goodmans Industries have evolved a design incorporating an acoustic resistance unit (ARU) which also gives an extended bass response, in accordance with the principles explained by E. J. Jordan (*Wireless World*, February, 1956).

Several new cabinet designs have been evolved by Wharfedale. One is for their new Bronze/CSB unit and another for the "Super 3" high-frequency unit, which is mounted with the axis vertical. A combination of these two (FS/10 Reflex), designed for use with stereophonic sound systems, was demonstrated.

Freedom from undesirable reverberation can often be achieved and economies in power requirements are always effected by the use of vertical line-source arrays of loudspeakers which can be graded to concentrate the radiation fanwise over an audience. Trix have now produced two such column speakers in atractive housings: Model CL80 (6ft) is rated for 6-10 watts and Model CL40 (3ft 3in) for 3-5 watts.



"Trixonic 800" combined amplifier and pre-amplifier.



Thermionic Products pre-amplifier (for TP100 10 watt amplifier).

Amplifiers.—Although three makers—Lustraphone, Grampian and Whiteley—were showing transistor a.f. amplifiers the valve amplifier is still the obvious choice for the majority of sound reproducing equipments.

E.M.I. who have hitherto confined their attention in the sound reproduction field to high-quality radiogramophones have now entered the market with a wide range of unit loudspeakers and amplifiers. Typical of the latter is the Model 3056, rated at 20 watts, which is of clean appearance with sunk valve sockets. Its associated pre-amplifier and equalizer Model 3055 is designed on miniature lines and uses the printed circuit technique.

A notably clean and accessible wiring layout has been adopted in the control unit of the Thermionic Products TP100 amplifier (10 watt). Blank wafers spaced behind the selector switches are used to support the components associated with the contacts, giving a neat and workmanlike appearance.

For those who do not require the pre-amplifier as a separate unit Trix have produced a single amplifier unit "Trixonic 800" rated at 8 watts in which the controls are partly shrouded on a sloping front panel. There is a rumble filter and automatic bass and treble compensation at low levels. Compensation for the characteristics of the ear is also available in the "Avantic" DL7-35 amplifier with which Beam Echo, Ltd., have entered the field of sound reproduction, and was noted also in the Pye HF5/8 which is of unit construction and is available either in chassis form or in a cabinet to match Pye loudspeakers.

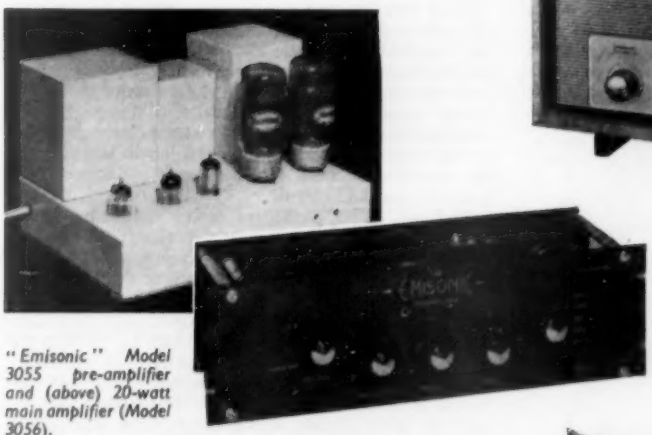
Built-in rumble filters to correct for the shortcomings of early gramophone motors are now seen to be fitted as a matter of course, and were noted among others in the R.C.A. High Fidelity amplifier and the Tannoy "Autograph" pre-amplifier.

A new type of "ultra-linear" feedback is introduced in the latest amplifiers by Lowther, who claim that the use of the suppressor grid for this purpose has improved performance.

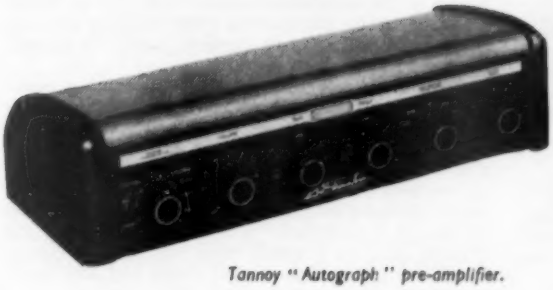
Radio Feeder Units.—Nowadays the majority of feeder units are for v.h.f./f.m. reception only, but C. T. Chapman (Reproducers) make a combined f.m./a.m. unit designed to extract the best possible reception from Continental medium- and long-wave stations and to give world-wide coverage on short waves. The sensitivity is of the order of 10 μV on all ranges. This firm also offers a fringe-area v.h.f. feeder-unit (FM81 Mk II) the sensitivity of which is stated to be 4 μV for 20 dB quieting.

Two marked trends are evident this year in v.h.f. receivers; the use of switched pre-set tuning for the three B.B.C. programmes and a real effort to secure frequency stability by one means or another. With luck and/or a lot of patience a straightforward circuit can show inherent stability through the mutual

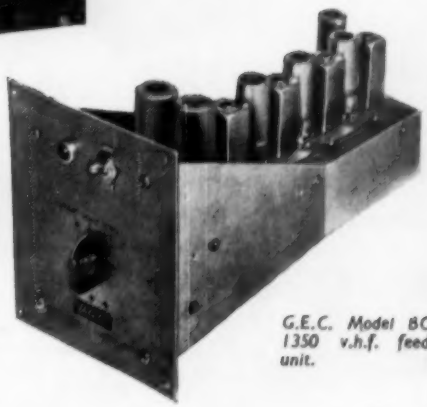
Above:—Pye HF5/8 amplifier in cabinet form.



"Emisonic" Model 3055 pre-amplifier and (above) 20-watt main amplifier (Model 3056).

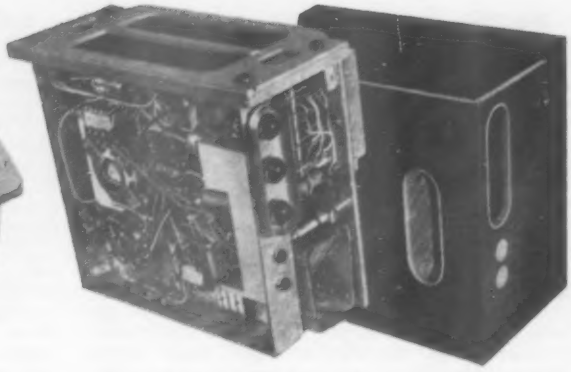


Tannoy "Autograph" pre-amplifier.

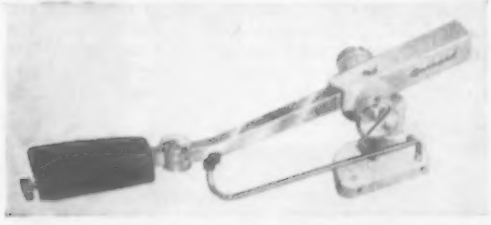


G.E.C. Model BCS-1350 v.h.f. feeder unit.

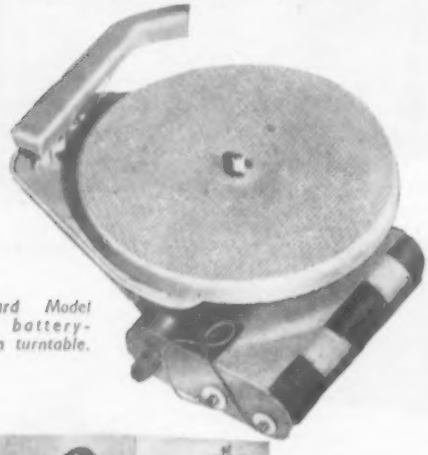
Ferrograph "66" tape recorder unit.



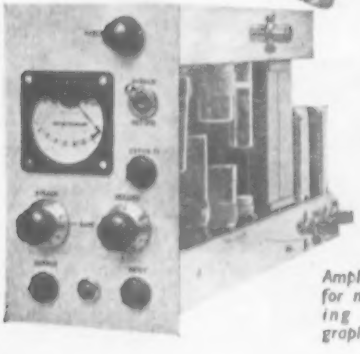
Truvox R1 tape recorder with chassis removed from case.



Garrard PA10 "transcription" pickup arm.



Garrard Model BA1 battery-driven turntable.



Amplifier "brick" for magnetic recording ("Reflectograph").

compensation of the effects of temperature change. The alternative is to apply some form of deliberate frequency control, e.g., through a reactance valve as in the new G.E.C. v.h.f./f.m. pre-tuned receiver (BCS. 1350), the Dynatron Type FM1, the Rogers RD Junior f.m. unit, and the R.C.A. New Orthophonic f.m. tuner, which is also interesting for its use of the 6AL7 tuning indicator which displays two rectangular fluorescent patterns of varying relative height.

Pye are fortunate in owning a subsidiary company which makes quartz crystals, and three (one for each programme) are incorporated in the f.m. unit which has been developed to work in conjunction with the "Black Box" record reproducer. An ECF80 triode-pentode is used to give successive frequency doubling and quadrupling from the crystal fundamental to the oscillator frequency.

Frequency control in the Leak f.m. tuner is effected by a "trough line" which consists of a straight wire surrounded on three sides by a metal channel. This is virtually a transmission line which is less affected by temperature than the coils and capacitors of a conventional LC circuit.

Pickups.—The cantilever stylus mounting which allows vertical displacement to absorb the pinch effect, while reducing the component transferred to the lateral movement to a minimum, is now widely used in pickups of the moving-iron (variable-reluctance), moving-coil and crystal types.

In the Tannoy "Variluctance Mark II" pickup the new "Complidex" stylus is of composite construction with magnetic and non-magnetic materials disposed to make the best use of the magnetic circuit and to give higher compliance with mechanical reliability. The R.C.A. "New Orthophonic" pickup is also of the variable-reluctance type with an 8-pole magnetic circuit designed to eliminate hum pick-up; the movement is encapsulated in plastic to exclude dust and moisture.

An entirely new moving-coil pickup with a cantilever stylus has been introduced by Garrard in which independent control of the lateral and vertical damping and compliance is allowed for. Another new Garrard development is the PA10 "transcription" pickup arm which is variable in length and tracking angle. Playing weight is automatically compensated when arm is extended. The thrust bearing for the vertical pivot is a single steel ball and horizontal pivots are spring-loaded steel cones and ball races.

Cosmocord have now developed a turnover pickup cartridge Type GP61 for tropical conditions with a ceramic piezoelectric element which is stated to give an average output of 0.4 volt on standard 78 r.p.m. and 0.1 volt on microgroove records.

Gramophone Turntables.—A 4-speed record changer (Type 456) with provision for manual as well as automatic operation has been introduced by Collaro. The fourth speed, 16⅔ r.p.m. is for "talking book" records, and the new mechanism incorporates automatic pickup positioning for mixed 7in, 10in and 12in records.

With a consumption averaging only ¼ watt the new Garrard Model BA1 battery-driven turntable created considerable interest. It is designed for small portable record players (with transistor amplifiers?) using 7in, 45-r.p.m. records and can be wound for any voltage (d.c.) up to 24. The standard rating is 4.5V, and a 6-volt battery with 25-ohm variable resistance is recommended to allow for voltage drop during the useful life of the cells. A centrifugal governor maintains the speed over the smaller voltage variations during an hour or so of use.

Magnetic Recorders.—Many unusual refinements are to be found in the M.S.S. Type PMR/10 transportable professional recording equipment. It is designed on the plug-in unit system and a wide variety of specifications can be met by the assembly of the appropriate miniature rack-mounted panels in the "electronics" section. The separate tape transport mechanism has interlocked controls to prevent accidental erasure and a delay mechanism prevents damage to the tape if the replay button is pressed while fast winding. An accurate linear footage indicator is driven by an independent tape capstan.

The tape transport mechanism and the electronic equipment are in separate units in the 8/WB/1 recorder made by Ariel Sound. This is designed to bridge the gap between the "home recorder" and "professional" types of equipment and is provided with separate record and playback channels with switching to monitor the programme before and after recording. A 4-channel microphone mixer unit can be supplied as an accessory.

Rudman Darlington ("Reflectograph") have developed a series of standard amplifier "bricks" for use in single-channel or stereophonic tape systems. They are equalized to C.C.I.R. standards and can be supplied to work in conjunction with either Wearite, Epsylon or Bradmatic heads. Separate playback or combined record-playback versions are available. The playback units have control panels 3in wide, and for multi-channel work up to six can be accommodated if desired in a standard 19in rack width.

To meet the requirements of those who consider that no high-quality sound installation is now complete without tape recording facilities, Wright and Weaire now supply their Ferrograph recorder in a form (Model 66) which can be readily fitted in a bureau draw or bookcase to blend unobtrusively with the furniture*.

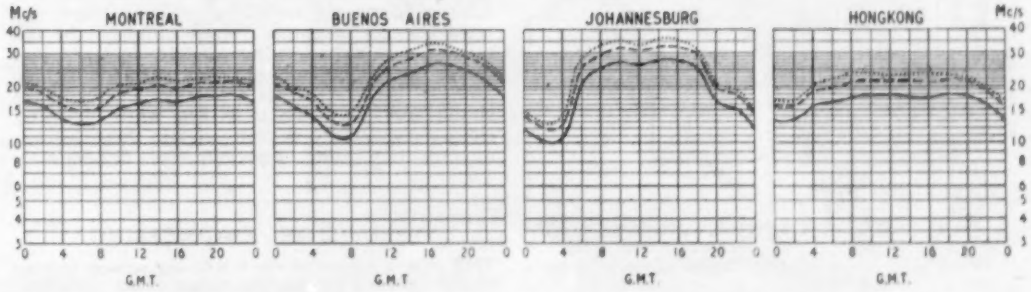
For the first time Truvox are supplying a complete portable recorder (Type R1) incorporating a new deck (Mark IV) with three motors and relay-operated function controls and brake mechanism. The power output is 4 watts into a 10in×6in elliptical loudspeaker.

A new Grundig model (TK5) is a single-speed machine (3¾in/sec) designed to give a performance comparable with the earlier TK9 at a reduced price. The interlocking controls are of the dial type.

The G.E.C. automatic announcer (BCS 3225) is a good example of an industrial application of magnetic recording. Up to 25 parallel tracks can be recorded on 3in wide tape and the appropriate track selected by push-button control of the transverse motion of a playback head. The tape is stored in folds in a large casket and foil contact strips are arranged to rewind the tape automatically at the end of each announcement. The mechanism has recently completed trials at a London station for train announcements.

* See, for example, "High Fidelity Home" by Richard Arbib, *Wireless World*, August, 1955.

SHORT-WAVE CONDITIONS *Predictions for July*



THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during July.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

F.M. TUNING METER

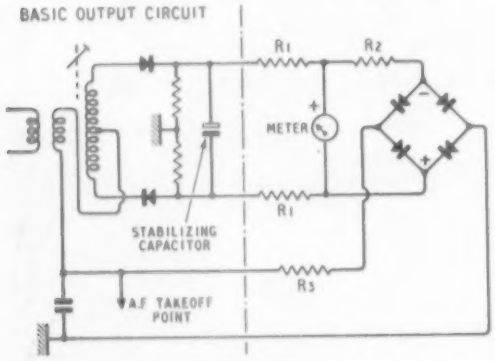
An Exact Tuning Indicator for Ratio-detector Type Circuits

By ROBERT S. FERGUSON,
B.Sc.(Eng.), Graduate I.E.E.

FOR undistorted reproduction of f.m. signals the i.f. characteristic should have a flat top a few hundred kc/s wide and the carrier should be in the centre of it. A voltmeter on the a.v.c. line, if any, or across the stabilizing capacitor of the radio-detector circuits, will indicate the same maximum reading anywhere on the flat top, giving no guidance to the centre point. Worse still, it will lead to completely unsymmetrical tuning if the i.f. is lopsided or dog-eared. The method is commonly used, however, as it permits the use of a "magic eye" indicator which demands an input with one side earthed.

Another type of meter circuit observes the d.c. voltage at the a.f. take-off point of the ratio-detector. This voltage is positive on one side of the correct tuning point and negative on the other, so that a centre-zero meter can be used to find the null point. The disadvantage, apart from the necessity for a centre-zero meter, is that the same (zero) reading is obtained on tune and well away from tune, making the reading difficult to interpret.

The circuit in the diagram combines the above two methods to give a meter reading which is a maximum on the exact centre of tuning and falls away to zero on each side. Imagine R_2 disconnected: if a signal is present the meter will read with the normal flat-topped i.f. response. If the remainder of the circuit is now connected any unbalance voltage at the a.f. take-off point will pass an opposing current through the meter, reducing the reading. The rectifier ensures that the current will oppose that through R_1 whatever the polarity of the unbalance voltage. If the unbalance is zero the opposing current is zero and the meter will read a maximum, but the slightest mistune will reduce the reading.



Circuit of the tuning indicator. Suggested values for the resistors (all ½-W) are:-

Meter Sensitivity	R_1	R_2	R_3
100μA	220k	10k	220k
250μA	100k	10k	47k
500μA	47k	22k	22k

The prototype circuit was tried out on a Jason tuner, but is basically suitable for any ratio-detector circuit. Suitable resistor values are suggested for several meter sensitivities, since one's choice here will depend on what is available. The rectifier is a 1-mA Westinghouse meter rectifier, commonly found in a.c. voltmeters.

The purpose of R_2 is to prevent the rectifier from shunting away from the meter part of the standing current through resistors R_1 and so reducing the maximum possible reading. The extent to which it does so depends upon the resistance of the meter movement, and the value of R_2 should be as low as possible. In some cases it can be zero, and a quick check (with R_3 disconnected) will show what is the smallest value which can be used without reducing the reading by more than, say, 10%. R_2 should be as high as possible to avoid shunting the a.f. output, but higher values will reduce the "sharpening" effect of the unbalance voltage. For this reason 500 microamps is about the least sensitive meter that can be used.

To decide on resistor values for a particular meter and tuner, first connect only the meter and resistors R_1 to the values in the table. Tune in a strong signal and vary the values of R_1 (keeping them equal) to give about 60% full scale or whatever is a convenient maximum reading. Now add the rectifier across the meter (the "wrong" way round, red output lead to negative meter terminal) with R_2 zero. If necessary, insert some resistance at R_2 as described above, to avoid a large drop in reading. Finally, connect R_3, using for a start a value equal to R_1, and try the effect of de-tuning. If it is not sharp enough, reduce the value of R_3.

It may be noticed that the meter reading is a bit unsteady-looking if the tuning is rapidly changed. This is due to the stabilizing capacitor preventing rapid changes of output voltage although the unbalance voltage changes immediately. In practice, of course, the tuning is moved slowly when approaching tune and the effect is not noticeable. Finally, if the output does not sound at its best when the meter reads a maximum it is pretty certain that the tuner requires re-aligning, especially the discriminator stage.

"TELEVISION ENGINEERING"

THE second volume of the B.B.C. engineering training manual with this title has been issued by our publishers. Volume 1 dealt with fundamental television principles, camera tubes and television and electron optics. This volume, by S. W. Amos and D. C. Birkinshaw, describes the fundamental principles of vision-frequency amplifiers and examines the factors which limit their performance at the extremes of the pass-band. Within its 270 pages are 133 figures, including several illustrations of picture faults. It costs 35s, plus 1s 2d postage.

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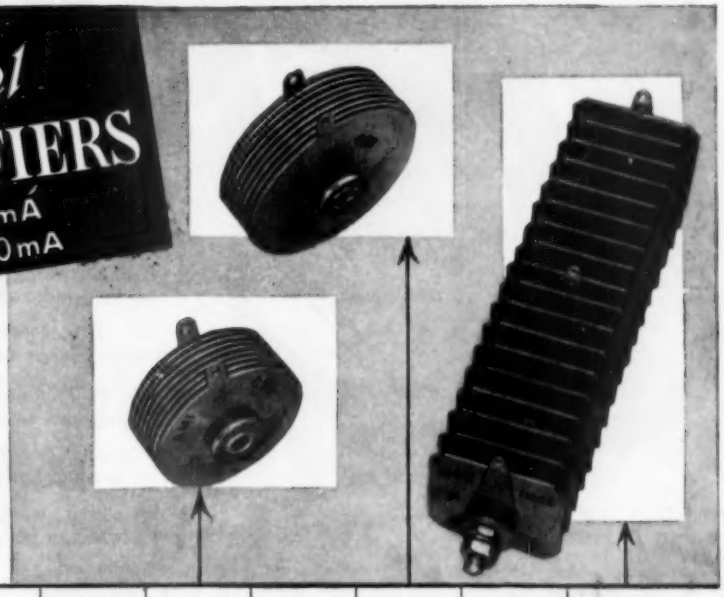

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Maximum ambient temperature	35°C 55°C	35°C 55°C	35°C 55°C	35°C 55°C	40°C 55°C	40°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA	100mA 60mA	120mA 90mA	250mA 125mA	300mA 150mA
Maximum input voltage (r.m.s.)	125V	125V	125V	125V	250V	250V
Maximum peak inverse voltage	350V	350V	350V	350V	700V	700V
Max. instantaneous peak current	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.	1.4 oz.	2 oz.	4.5 oz.	4.75 oz.

* For use in voltage doubler circuits the peak inverse and maximum input voltages are halved, current output being as for half wave operation.

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(We shall not worry you with personal visits) JULY 1c38a

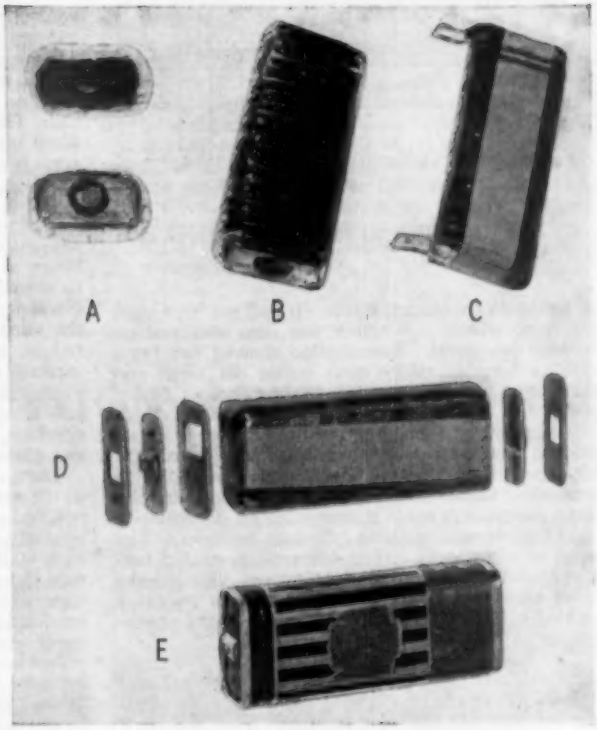
Wafer Cells

New Departure in Dry-Battery Construction

By R. W. HALLOWS,
M.A. (Cantab), M.I.E.E.

WHEN the dry Leclanché cell first appeared I am not quite sure, but it was certainly more than half a century ago and may well have been considerably earlier than that. In most kinds of electrical apparatus developments and improvements follow one another with such rapidity that it is difficult to think of anything of comparable seniority whose outward appearance, at any rate, has remained unchanged. But, except for the types used in layer-built batteries, this was true of the dry cell until the Burgess Battery Company, of U.S.A., announced a short while ago the commercial production of their "wafer cell."

If one compares the internal construction of the standard cylindrical dry cells of to-day with that of their ancestors, there have been certain changes—all of them improvements, but not very great changes. The sac, which used to contain the depolarizer surrounding the central carbon electrode, has now disappeared from most if not all of them; different makers use their own special mixes of electrolyte and of depolarizer. But the basic make-up of zinc can, sal-ammoniac electrolyte, manganese dioxide depolarizer and brass-capped carbon rod remains very much the same as it was in the beginning. The greatest major change is, perhaps, the use of solid-drawn instead of soldered cans in high-grade cells. The advantage of the solid-drawn can is that it contains one metal only—zinc. Soldering the side-seam and the bottom introduces at least two others, tin and lead, whose presence may lead to undesirable electro-chemical effects.



Method of making up wafer cells into batteries: A, individual cells, showing positive (top) and negative (bottom) faces. B, 15 cells, stacked and heat-sealed into polyester plastic envelope. C, stack taped with positive and negative metal-strip contacts. D, Metal-strip contacts folded down, insulating plates and terminal studs. E, the complete 22½-volt battery sealed into an aluminium container.

The Burgess wafer cell is revolutionary, to say the least of it. Fig. 1 shows semi-diagrammatically how it is constructed. The zinc and carbon electrodes, the electrolyte and the depolarizer, are all there as they always have been, and always must be, in a dry Leclanché cell. But in appearance, in internal make-up and in performance, size for size and weight for weight, the wafer cell is about as different as it possibly could be from the dry cell to which we have become accustomed.

It consists, as the drawing shows, of a sandwich, the electrolyte and depolarizer forming the "meat" between thin slices of carbon and zinc. All four edges of the sandwich are bitumen-sealed, and the whole cell is contained in an envelope of a plastic material known as Pliofilm.

This envelope method of construction is itself an enormously important advance, for it means that the cell cannot puncture. The Pliofilm envelope is completely impervious to the chemical action of either electrolyte or depolarizer and, as its name suggests, it can stretch. It is, in fact, well able to take charge of any gassing that may occur in the cell, without the slightest risk of a burst or a puncture.

Many readers will know by experience what a big step forward this is, having suffered from the devastating effects of a ruptured dry cell in the "innards" of electrical appliances of various kinds. Only a day or two ago, a friend showed me ruefully the wreck

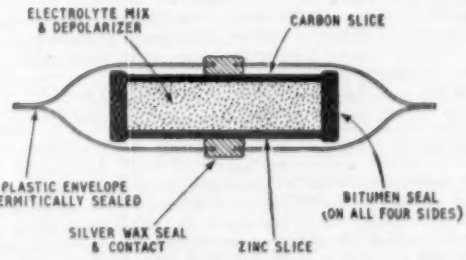


Fig. 1. Showing semi-diagrammatically the construction of the wafer cell.

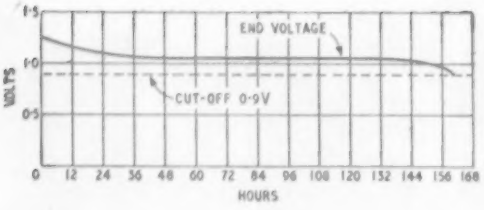


Fig. 2. Discharge through 1,500 ohms for 4 hours per day of "U" wafer cells.

of an expensive electric torch. It had not been used for some weeks. When it was next switched on nothing happened. Examination showed two burst cells, a horrible sticky mess inside the torch and damage by corrosion that was beyond repair. I have suffered in the same way from the effects of a punctured cell which formed part of the dry battery incorporated in the resistance-measuring department of a high-grade (and therefore not low-priced) multi-range measuring instrument. Assurance against damage from puncture is made doubly sure by the methods used for assembling these cells into batteries. The stack of wafer cells is first hermetically sealed into a polyester wrapper and then packed into a leak-proof aluminium container. The various stages of making a wafer cell battery are shown in the photographs.

The manufacture of these wafer cells is entirely automatic: it represents, in fact, complete automation in the production of dry cells. The materials are fed into one end of a machine; from the other the finished cells are delivered. This in itself is bound to lessen the cost of production. But there is more to it than that.

Conserving Zinc

In previous articles in *Wireless World* I have drawn attention to the appalling waste of zinc—by no means one of our commonest or least costly metals —which takes place, year in, year out, in the countless millions of cylindrical dry cells used in the world of to-day. The upper part of the can is not in contact with the electrolyte and there is very little chemical action on its lower part, or on the bottom. Such cells run down to cut-off e.m.f. after delivering only a small percentage of the electro-chemical equivalent of the zinc in their cans. They are then consigned to the dustbin, for the zinc that they contain would not pay for the cost of recovery.

The sandwich method of construction means that the zinc is not called on to form the container of the cell. Generally speaking, all parts of it are equally acted upon by the electrolyte. Nor would it be of great importance it it were eaten through and punctured in one place. Since the cell is hermetically sealed in its impervious envelope, there would be no loss of moisture. This method then means that the amount of zinc needed to supply the rated amperehours of a cell of given capacity can be cut down to something far less than is required in the cylindrical cell. Zinc is a difficult metal to refine, but that used in the wafer cell is 99.9% pure. This must reduce local action to a minimum and greatly increase shelf life.

The reader may be wondering how it is that, if the cell is sealed in an impervious, insulating plastic envelope, external contacts with its positive and negative electrodes are contrived.

The answer is this. After being formed and sealed in the machine each cell passes to a compartment in which, accurately centered up, it has small holes pierced in the top and bottom of the envelope. Into each of these (see Fig. 1) is pressed a "blob" of a softish, highly conductive compound, known as silver wax. This hermatically seals the holes in the envelope and provides the external contacts. Silver wax never becomes entirely rigid. Hence, when the individual cells are made up into batteries the contacts between them remain electrically as good as could be desired, even if the casing of the battery is deformed by rough treatment. There are no soldered joints, as there are in the ordinary dry battery, and open-circuits due to dry joints or faulty workmanship cannot occur.

At present, the Burgess Battery Company is making the wafer cell only in five rather small sizes, which, as shown in the Table, are intended for use in transistor-operated apparatus, in hearing aids and as h.t batteries in small portable wireless sets. There is no reason why they should not be made in much larger form, and this will no doubt come in time. The only weak point I can find in these wafer cells is their rather high internal resistance. Despite that, their performance is good.

I received batches of Y and U cells—don't, please, confuse this latter size with our British U cells. The

CHARACTERISTICS OF WAFER CELLS ON THE U.S. MARKET

Cell Type	Length (in)	Width (in)	Thickness (in)	Rated Load (Ohms)	Normal Current (mA)	Life to Cut-off (1 V)	Intended Use
Y	$\frac{5}{16}$	$\frac{5}{16}$	0.12	3,000 per cell	0.5	175 hrs at 12 hrs per day	Transistor Apparatus
U	$\frac{13}{16}$	$\frac{13}{32}$	0.11	1,500 per cell	1.0	150 hrs at 12 hrs per day	Transistor Apparatus
K	$1\frac{1}{4}$	$\frac{13}{32}$	0.13	1,500 per cell	1.0	375 hrs at 12 hrs per day	Transistor Apparatus
N	$1\frac{1}{4}$	$\frac{13}{32}$	0.21	166.6 per cell	9.0	53 hrs at 4 hrs per day	H.T. in portable radio
P	$\frac{13}{16}$	$\frac{13}{16}$	0.22	166.6 per cell	9.0	45 hrs at 4 hrs per day	H.T. in portable radio

Y size is stated to have a life of 175 hours at 0.5 mA, if used for 12 hours per day. The life claimed for the U size at 1.0 mA, discharged for the same periods, is 150 hours. The cut-off in both cases is that obtaining in America: 1.0 V per cell. We usually regard the cut-off for dry cells as 0.9 V.

For my tests I took three U-size cells and discharged them through 1,500 ohms apiece for twelve hours a day. Fig. 2 shows the results obtained, the term "end voltage" meaning the average e.m.f. under load at the end of each day's run. It will be seen that they delivered almost the 150 hours claimed to a cut-off of 1.0 V and that their average life to 0.9 V was 159 hours. The reason why the life to 1.0 V was a little under 150 hours is probably that Americans keep their living room (and test laboratory) temperatures at 70°F or more, whilst we regard 65°F as sufficient. The ambient temperature makes a good deal of difference to a dry cell's performance.

Summing up, I think that we may fairly say that these wafer cells mark noteworthy advances in reduced production costs, in the more effective use of materials, in the abolition of the possible damage due to punctures and in the considerably smaller size of cells of performance equal to that of their cylindrical counterparts.

"PRECIPITATION STATIC"

American Investigations into its Causes

IT was observed when aircraft were first equipped with radio that serious interference occurred if the aircraft flew into snow. The phenomenon was named "precipitation static" because of its association with snow storms. During the last World War a large-scale research programme was sponsored jointly by the U.S. Army and U.S. Navy in an effort to solve the problem.

The Stanford Research Institute of California is at present conducting research into the phenomenon of precipitation static. The studies show that there are at least three different noise-producing mechanisms contributing to the interference, where only two had been recognized previously. The best known of these is associated with what has been called "autogenous charging." The aircraft, flying through snow or through high clouds which are composed of ice particles, is peppered by the particles and is charged to a high voltage by the same mechanism that causes certain substances to become charged when rubbed with a dry cloth.

The electrical charge builds up until it is relieved by a corona discharge from the wing tips and other extremities. Corona discharge, known to mariners as St. Elmo's fire, occurs as a series of very short pulses. It is a potent generator of electrical noise.

Charged Surfaces

Another type of "precipitation static" noise is produced in aerials mounted under plastic surfaces such as canopies and radomes. Ice particles striking the plastic surface charge it to a high voltage relative to the surrounding metal portions of the aircraft. The charge rapidly builds up until a sparking or "streamering" discharge occurs between the plastic surface and the surrounding metallic structure, with consequent transfer of severe noise into the aerial.

The third mechanism, only recently discovered, by which impinging precipitation produces noise is associated with the effect of individual particles. It was at first expected that the noise generated in antennas under plastic canopies could be avoided by the elimination of the over-surface sparking or streamering. This, in turn, could be accomplished by coating the surfaces with a semiconductor which allows the charge to drain off gradually rather than build up to the high values which cause sparking. However, when tests were made it was observed that although the noise was reduced by the conductive coatings it was by no means eliminated.

The residual noise has now been found to be due to an individual particle effect. As the aircraft speeds through the air the snow or ice cloud particles approach it uncharged. As they strike the aircraft they both acquire a charge themselves and leave a charge of opposite sign at their point of impact on the surface of the aircraft.

Cumulative Effect

It has been shown theoretically that the effect of the particles instantaneously acquiring a charge upon striking the plastic surface covering the aerial and then glancing off and moving rapidly away from the point of impact is to produce a small but steep-fronted pulse of current at the aerial terminal. While the effect of each particle is small, the effect of many, closely spaced in time and arriving at a random rate, is to produce serious noise.

Experimental study of the phenomena described has been undertaken by the design of a unique "wind tunnel" in which to simulate actual precipitation conditions encountered in the atmosphere. For this, use was made of Stanford Research Institute's cold chamber, constructed a few years ago for the study of the nature and causes of ice fog.

A 150-gallon vacuum tank, fitted with an inlet orifice and tube shaped for proper aerodynamic flow and incorporating a quick-opening valve, was placed in the chamber. The tank also contains a plastic plate carrying sensing electrodes and a sensitive preamplifier. Air is pumped from the tank, and when a sufficiently low pressure is reached the inlet valve is opened. Ice fog, which has previously been produced in the cold chamber by the introduction of steam followed by seeding with dry ice, rushes into the vacuum tank at a speed of approximately 250 metres per second—nearly 10 miles per minute. The stream of ice fog impinges on the plastic surface permitting study of the basic effects contributing to precipitation static.

Simple Telephone Answering

DESIGNED FOR MINIMUM INTERFERENCE WITH POST OFFICE EQUIPMENT

By H. G. M. SPRATT, B.Sc., M.I.E.E.

THE idea of a robot which answers the telephone is not new and more than one device designed for this purpose has been produced and marketed. Furthermore, the particular advantages of magnetic recording in such devices for acknowledging calls and taking down messages have not been overlooked. So far, however, a specially designed recording machine has had to be employed for the purpose and its installation has necessitated breaking into the telephone lines or receiver, a step which, carried out without the knowledge, consent and co-operation of the Postmaster General, may lead in due course to the police court—or even one higher.

The telephone answering machine to be described in this article represents an entirely new approach to the problem.* Its principal features are (1) that it takes the form of comparatively simple adjuncts to any normal type of magnetic recording machine and (2) that, as regards its respect for the sanctity of Post Office equipment, it is virtually superhuman. The adjuncts are three in number. Two of them, consisting of a relay and a coupling coil, are attached to the normal telephone receiver as shown in Fig. 1 (a) and (b). The third is a control unit, Fig. 2, which is connected by leads to the other two and to the tape recorder. The last-mentioned can be any conventional model but in some cases a few trifling modifications to the internal wiring may have to be introduced.

The coupling coil is attached to the side of the telephone receiver by means of the rubber sucker provided, while the foot of the relay unit is slipped under the receiver so that, with the hand-set removed, the relay armature holds down the cradle switch. The connections of these units to the control unit are shown in Fig. 3.

The control unit embodies an endless loop of magnetic tape about 20ft long with a simple motor drive, a number of free-running guides, a pair of contacts which "make" through holes punched in the tape and a playback head. In addition, there is a small mains transformer, two simple relays RL_1 and RL_2, a 4-bank 3-way stepping relay RL_3 with a microswitch coupled to it, and a 2-bank 3-way manually operated switch S_1.

Two pairs of leads connect the control unit to the coupling coil and the relay and three pairs of leads connect it to the tape recorder. One pair is connected to the amplifier input, one to the amplifier output and the third into the mains feed to the capstan motor. The extent to which the internal wiring of the recorder may have to be disturbed to complete these connections is discussed later.

When the instrument is intended to be put into use, the coil and relay are placed in position, the connections made to the recorder and the mains

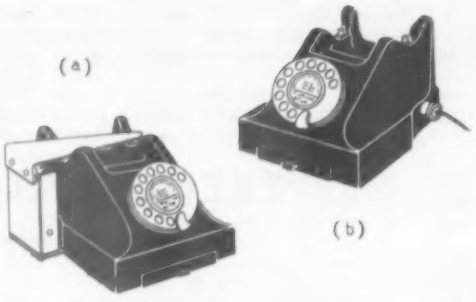


Fig. 1. Telephone receiver showing (a) the relay assembly clipped in position and (b) the coupling coil attached to the side.

switched on to both recorder and control unit. The recorder is set to RECORD and the control unit to AUTO. Note: because of the connections from the capstan motor to the control unit, the recorder drive does not immediately start up.

When the telephone rings as the result of an incoming call, the relay holding down the cradle switch is released. The caller then hears a message played back off the endless loop of tape informing him that the caller is absent and inviting him to dictate a message not exceeding a minute's duration. If the caller accepts this invitation, any message he passes is recorded on the tape recorder. At the end of the minute, the relay is released and the telephone is disconnected, ready for the next call. With the help of Fig. 3, it is possible to follow the detailed operation of the instrument.

The endless loop of magnetic tape, which can be of any of the normal proprietary makes, is made up of a length corresponding to 70 seconds playing time at $3\frac{3}{4}$ in/sec, the speed of the control unit drive. At the joint and at 10 seconds farther along, small holes are punched in the tape through which contact can be made between a beryllium spring and a guide roller on the other. In the waiting condition, the joint in the loop of tape will be just past the switch SW.

When the telephone rings, the ringing current induces a voltage in the coupling coil which is fed through RL_{2a} to the tape recorder input. After amplification in the record amplifier, it passes through RL_{3b} to operate the relay RL_1. RL_{1a} contacts close, energizing RL_2 from the mains supply. RL_2 in turn causes RL_3 to be energized from the transformer secondary winding through RL_{2a} and to step from position 1 to position 2.

In position 2, RL_1 is energized from the secondary of the mains transformer through RL_{2d}, releasing the cradle switch and closing the speech circuit in the telephone receiver. The indicator lamp also

* Patent Application 13195/55. A. S. Blaikley and N. Moore, Magnegraph Recording Company.

lights up. RL_1 is disconnected from the output of the tape recorder at RL_{2b} and in opening de-energizes RL_2 and hence RL_3 as well. At the same time, the loop motor is connected across the mains at RL_{2c} and starts the tape loop in motion. The playback head is connected to the input of the tape recorder at RL_{2a} and the coupling coil to the output of the tape recorder at RL_{2b}. Simultaneously, the microswitch RL_{2e} closes, starting up the drive in the tape recorder.

The first 10 seconds of the tape will have been recorded earlier as stated above and the message on it is now played back through RL_{2a}, the tape recorder amplifier, RL_{2b} and the coupling coil to the speech coil of the telephone receiver. The announcement inviting the caller to dictate a message terminates just before the end of the 10-second period, at which point the contacts of the switch SW "make" through the first perforation in the tape loop, energizing RL_2 momentarily and causing RL_3 to step to position 3.

In position 3 the playback head is disconnected from the tape recorder input at RL_{2a}. The coupling coil is disconnected from the tape recorder output at RL_{2b} and connected instead to the input at RL_{2a}. The recorder output is connected to earth through the dummy load R.

Any message now spoken by the caller is picked up by the coupling coil and recorded on the tape recorder. At the end of the one-minute period the tape loop in the control unit will have completed one cycle and the second perforation passes between the contacts of SW. RL_2 is again energized through RL_1 and steps on, this time back to its initial position 1.

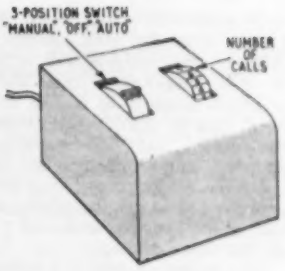


Fig. 2. Control unit, with three-position switch and counter registering number of calls.

The whole equipment reverts back to the original condition. RL_4 is released, causing the cradle switch to be depressed and the call terminated, and both tape-drive motors, one in the control unit and the other in the recorder, stop. With the arrival of another call, the sequence of operation will be repeated.

If, on returning, the subscriber plays back the reel on his recorder in the conventional manner, he will hear not only the messages passed by the various callers but also the announcement from the loop preceding each message. It is possible, if desired, to couple up a counter to the stepping switch RL_3, as indicated in Fig. 2, so that the number of calls recorded can be checked.

With the switch S_1 in the OFF position, the mains supply to the control unit is broken. This unit is

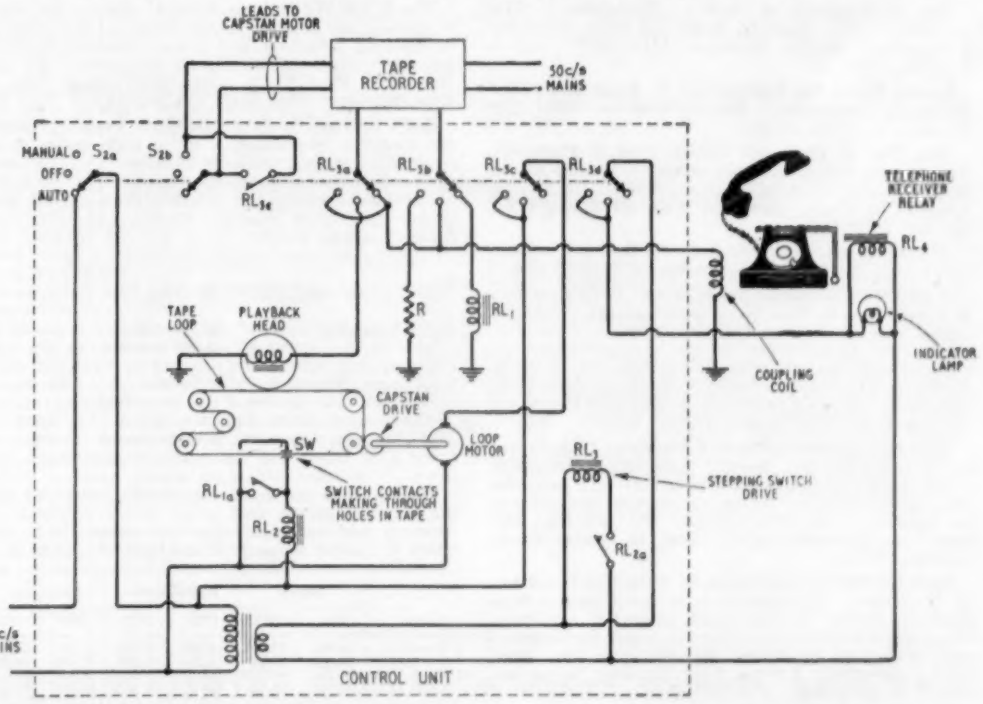


Fig. 3. Complete circuit diagram of the equipment, the contents of the control unit being enclosed by the broken-line box.

then inoperative and, since the microswitch RL_{3a} is left open, the tape recorder is inoperative also. With S_2 in the MANUAL position, the control unit is still inoperative but the microswitch RL_{3a} is short-circuited at S_{2b} so that the tape recorder drive can be started and stopped independently of the control unit. Under these conditions, with the coupling coil attached to the telephone receiver but the relay armature removed from the cradle switch, it is posible to use the telephone in the normal way and at the same time record two-way conversations on the tape recorder.

The extent to which a normal tape recorder has to be modified for use in connection with this telephone answering device depends upon the model and the facilities provided. If, for example, an EXTERNAL L.S. socket is fitted, this socket will, without further ado, provide the necessary permanent connection to the amplifier output. Again, if the tape recorder is intended to be used with a remote control device, such as a foot switch, the socket into which this device is plugged provides access to the capstan motor supply. Clearly, in the absence of these sockets, the necessary connections will have to be brought out from the internal wiring. Since whenever the recorder is used in conjunction with the control unit, it operates in the RECORD position, access to the amplifier input is always available through the MICROPHONE socket.

Although of quite recent development, this telephone answering machine has been tested many hundreds of times and found to operate infallibly on all occasions. It will almost inevitably be argued that one minute is insufficient time for the average message to be passed. In practice, one minute is found to be long enough to record a message of surprising length, the fact that any opening conversation regarding the weather, the state of one's health or business conditions is excluded helping appreciably in this connection. However, if one minute is considered inadequate, a simple modification enables the tape length to be extended appreciably and the maximum message time increased. A possible alternative to the loop of tape is a magnetically-coated disc riding on a turntable and fitted with limit stops. The same general principles of operation still apply but contacts made through holes in the recording medium are now avoided and changing of the earlier recorded message is likely to be facilitated. Whatever the form of the detailed design, however, an apparatus of this simplicity should prove of very considerable benefit to many telephone subscribers but particularly those who are running a one-man business.

BOOKS RECEIVED

British Standards Yearbook 1956. (Complete to 31st December, 1955.) Gives titles, numbers and brief synopses of British Standard specifications (in numerical order). Pp. 460. Price 12s 6d.

The Performance of Power Transformers (Not exceeding 2 kVA rating) for Radio and Allied Electronic Equipment. British Standard 2214:1955. Pp. 9. Price 3s

Colour Codes for Connections in Radio and Allied Electronic Equipment. British Standard 2311:1955 Pp. Figs. 1. Price 2s 6d.

The Use of Electronic Valves, Part 3: Photocells, Transmitting Valves and Cold-cathode Gas-filled Valves. British Standard Code of Practice CP 1005 : Part 3 : 1956. Prepared by a joint committee of the I.E.E. and B.S.I. Pp. 16. Price 3s.

The above are obtainable from the British Standards Institution, 2, Park Street, London, W.1.

A Stable Synchronous Detector for Audio-frequency Measurements, by P. G. Kendall, B.Sc.(Eng). Technical report V/T125 dealing with the design and performance of a detector for use in a.c. servo-operated potentiometers and electronic wattmeters. Pp. 18; Figs. 8. Price 12s 6d. The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Electronic Measurements and Measuring Instruments, by F. G. Spreadbury. Review of the basic elements of a wide variety of measuring instruments with particular emphasis on stability, the use of negative feedback and the stabilization of power supplies. Pp. 459; Figs. 248. Price 50s. Constable and Co., Ltd., 10, Orange Street, London, W.C.2.

High Fidelity Circuit Design, by N. H. Crowhurst and G. F. Cooper. Collection of a series of articles from *Radio-Electronics* on the detail design of amplifiers, filters and equalizers, test procedures and the improvement of existing amplifiers. Pp. 303; Figs. 226. Price $5.95. Gernsback Library Inc., 25, West Broadway, New York 7, U.S.A.

Metal Industry Handbook and Directory 1956. Comprehensive guide to the properties and sources of supply of non-ferrous metals with a section on electroplating and allied processes. Pp. 508. Price 15s. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

The V.T.V.M., by Rhys Samuel. Manual for service technicians on the use of the vacuum tube voltmeter in checking television and sound broadcast receivers, amateur transmitters and audio equipment. Pp. 224; Figs. 127. Price $2.50. Gernsback Library Inc., 25, West Broadway, New York 7, U.S.A.

Hi-Fi Manual, by D. C. Hoefler. Popular guide to the essential requirements of a high-quality sound reproducing system, profusely illustrated by examples of current American equipment. Pp. 144. Fawcett Books, Greenwich, Connecticut, U.S.A. Price 3s 6d from British distributors Fredrick Muller, Ltd., 110, Fleet Street, London, E.C.4.

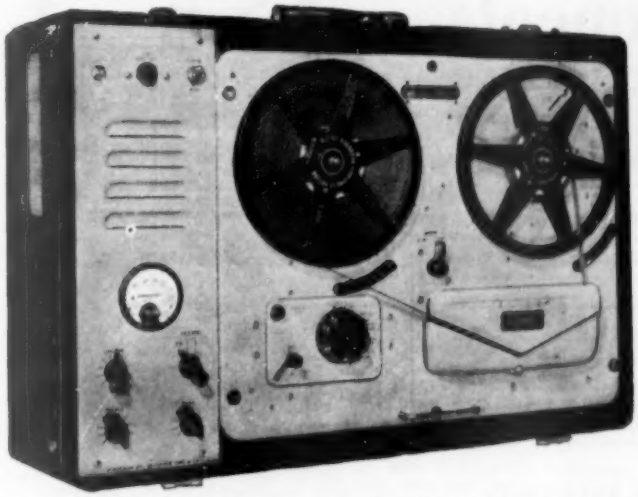
RECEIVER SALES

THE "seasonal decline" in the sales of domestic receivers in the United Kingdom is shown in this table compiled from information supplied by the British Radio Equipment Manufacturers' Association. The figures for the first four months of this year show that the sales of television receivers remain at about 17% below the 1955 level for the same period, sound receivers are about 27% down and radio-gramophones about 45% down.

During April no significant change, compared with the previous month, took place in the proportion of receivers sold under hire purchase—sound 30%, television 45%—but radiograms rose from 54% to 63%.

	Sound		Radiograms		Television	
Month	1956	1955	1956	1955	1956	1955
January ...	66,000	98,000	18,000	35,000	85,000	103,000
February...	66,000	99,000	15,000	33,000	81,000	98,000
March ...	72,000	95,000	13,000	24,000	71,000	85,000
April	65,000	79,000	14,000	16,000	62,000	75,000
	269,000	371,000	80,000	108,000	299,000	361,000

VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 30lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The total hum and noise at 7½ inches per second 50–12,000 c.p.s. unweighted is better than 50 dbs.
★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.
★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.
★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.
★ A heavy mu-metal shielded microphone transformer is built in for 15–30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.
★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.
★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.
★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

POWER SUPPLY UNIT

to work from 12 volt Battery with an output of 230 volts, 120 watts, 50 cycles, within 1%. Suppressed for use with Tape Recorder. **PRICE £18.**

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is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.
It is recommended by a number of tape recorder manufacturers for this purpose.
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15–30 ohms balanced.
The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.
The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.
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Rectangular panel instruments are available with scale lengths of 2.5in., 3.2in., and 4.2in. These offer the advantage of an increase in scale length of approximately 50% over their equivalent round models, for which they can be used as direct replacements using the same panel fixing holes.

Larger instruments, both round and rectangular and for switchboard or panel mounting are also available. These have scale lengths of 6in. and 6¼in. respectively.

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Mains voltage: suitable for A.C. only, 105 – 115, 190 – 210, 210 – 230, 230 – 250 volts, 50 cycles. Power Consumption: approximately 90 watts maximum. Mains Fuses: 2 amps (for 105 – 115 volts), 1 amp (for 190 – 250 volts). H.T. fuses: 500 m/A Surge Resisting, 120 m/A Surge Resisting. Valve line-up: EF 86, ECC 81, EL 84, EL 42, EM 71 + 2 metal rectifiers. Mains tapping panel and fuses instantaneously available. Two tape speeds — 3¾ ins/sec and 7½ ins/sec: speed change instantaneous by electrical means – heavy duty dual speed split phase induction motor: recording time (with 1,200 feet recording tape) 2 × 30 minutes at 7½ ins/sec – 2 × 60 minutes at 3¾ ins/sec: half track recording, track change without spool reversal: track changeover by press button approximately 2 seconds. Trackbutton remains down to indicate which track was played last: frequency range 50 – 9,000 cycles at 3¾ ins/sec, 40 – 14,000 at 7½ ins/sec: noise is down at least 40 dBs and wow and flutter less than 0.3% at 7½ ins/sec, less than 0.5% at 3¾ ins/sec.

Automatic stop foil at end of spools: fast forward and fast rewind time approximately two minutes per full spool. Illuminated precision place indicator: recording level meter by 'magic eye', tone control for treble or bass emphasis.

Loudspeakers: elliptical high-flux permanent magnet moving coil + two 2½ inch tweeters. Special four-position speaker control. Connections for low impedance extension speaker and high impedance external amplifier remote controls, earphones. Microphone, diode and radio input sockets.

Overall dimensions: 17 inches × 17½ inches × 9½ inches. Weight approximately 48 lb.

Retail Price **98 gns.**

GD273

European V.H.F. Broadcasting

Present Position and Prospects

By G. H. RUSSELL, Assoc.Brit.I.R.E.

As a result of an enquiry conducted among the broadcasting organizations in Europe, a report[1] dealing with some of the technical, economic and sociological questions arising out of the introduction of v.h.f. broadcasting has been issued by the European Broadcasting Union. Although it does not go deeply into technical details—this will be done in a second report—it gives an overall picture of the present situation and the immediate prospects in Europe.

It opens by stating that v.h.f. sound broadcasting has, in general, been adopted with considerable reluctance by European broadcasting authorities and the consensus of opinion is, in the words of our own Television Advisory Committee, that "the introduction of v.h.f. sound broadcasting is an unwelcome complication." It has, of course, become a necessity because of the prevailing conditions in the medium- and long-wave bands—for which incidentally these selfsame authorities are largely to blame. The situation in these bands was summed up in a recent article in *Wireless World*[2] but one or two new facts are brought out in this report. For instance, it is stated that in Denmark a field strength of 25 mV/m is required to give a clear signal after dark. In Italy, only 30% of the population can receive all three national programmes, and in Switzerland there has been no satisfactory service to 11% of the territory since the Copenhagen Plan came into force in 1950.

Whatever the reasons for the introduction of v.h.f. broadcasting, the building of transmitters is going ahead at a great pace as is shown by the accompanying table. Between 1st July, 1955, and 1st January, 1957, the scheduled increase in the number of these transmitters is from 210 to 542. Although this latter figure represents less than a third of the total number of allocations made at Stockholm, it is nevertheless quite impressive and probably represents a large proportion of the eventual total.

Transmitters without listeners are not much use. In general the listener has to be persuaded to change his listening habits, although in the Netherlands the demand for v.h.f. receivers was created to some extent by the fact that German f.m. stations are receivable in many parts of the country.

Listener Inducements

Although the B.B.C. is pressing on with the building of v.h.f. transmitters, it has so far done little, either in the way of special programmes or higher-quality transmissions, to induce listeners to change to v.h.f. This is in sharp contrast to the French organization, R.T.F., who are of the opinion that the public will never really be converted to the new medium unless a supplementary high-quality programme is provided. They have put theory into practice by broadcasting a fourth programme on v.h.f. which is carefully planned to entice the type of listener who would appreciate first class reproduction. This theory has been substantiated in practice by the Germans who found that, in spite of worsening conditions in the medium-wave band, public interest in v.h.f. was not particularly marked until a separate programme was radiated in this band. "From that time dates the steady increase in the percentage of receivers having provision for v.h.f. reception." It will be interesting to watch the sales figures of v.h.f. receivers in this country. The B.B.C. may yet be forced to inaugurate a special high-quality programme in order to excite public interest. In view of increasing public appreciation of the advantages of "high fidelity", such a service would undoubtedly be received with considerable enthusiasm and might succeed in stopping the flight to television.

This brings us to another aspect of the situation. Most of the broadcasting authorities, including the B.B.C., are of the opinion that sound broadcasting will survive the advent of television and that it will even continue to develop. Whether the word "develop" in this context refers to quality or quantity is not clear. Whatever it means, the optimism seems somewhat misplaced, at any rate as far as the B.B.C. is concerned. Its own listener research figures show a steady decline over recent years in public interest in sound broadcasting to the advantage of television. Instead of being complacent, we might perhaps be asking at this stage whether it would not be advisable

[1] "The Present Position and Prospectives of V.H.F. Sound Broadcasting in Europe", E.B.U. Report, Tech. 3068-E.
[2] "Future of European Broadcasting", January, 1956.

BAND II TRANSMITTERS

	Stockholm Plan	In Service	
		July, 1955	Jan., 1957
Albania	8	—	—
Austria	28	10	24
Belgium	25	1	1
Bulgaria	19	—	—
Cyprus	1	—	—
Czechoslovakia	25	—	—
Denmark	41	2	8
Finland	58	17	23
France	178	2	9
German Federal Republic	246	117	123
Germany, Soviet Zone	16	12	26
Hungary	25	—	—
Ireland	10	—	?
Italy	189	34	260
Luxembourg	2	—	—
Malta	1	—	—
Monaco	3	—	—
Netherlands	25	3	13
Norway	124	2	7
Poland	54	—	—
Rumania	34	—	—
Saar	3	1	2
Spain	81	—	—
Sweden	96	2	?
Switzerland	40	2	13
Trieste	4	—	—
Turkey	87	—	1
United Kingdom	190*	3	30
U.S.S.R.	221	†	—
Vatican City	2	2	2
Yugoslavia	88	—	—
	1,924	210	542

* Only 79 were for f.m., the remainder were for use if a.m. had been adopted.
† V.H.F. activity in Eastern Europe is at present confined to Band I.

either to reduce the number of programmes from three of mediocre quality to two of high quality or make one of the three for the quality enthusiast.

Turning to the technical aspects of v.h.f. broadcasting, we come first of all to the question of modulation. Frequency modulation has, in most cases, been accepted without question. Indeed, in some countries, one might be forgiven for assuming that v.h.f. and f.m. are synonymous. Even in the few countries where the question has been examined the opinions are quite extraordinary. The Germans, for example, state that the cost of a f.m. receiver for equal and even superior quality is less than the cost of an a.m. receiver. Swiss manufacturers are confident that they can produce a combined v.h.f.-f.m./m.w.-a.m. receiver costing no more than a conventional receiver. This has not been so in this country. It would be intriguing to know how a receiver containing at least one extra valve with its associated components can be constructed for the same price as one without it.

Another opinion from Germany that is worth quoting is, that, as an r.f. protection ratio of only 20 dB is required with f.m. as against 40 dB for a.m. for an equivalent a.f. protection ratio, it is possible to have a smaller geographical separation between transmitters working in the same channel. This factor more than makes up for the fact that the number of available channels is very much lower for f.m. than it would be for a.m. The number of transmitters using a given waveband can be increased by offsetting the carriers of stations nominally operating in the same channel. The Germans have had considerable experience of this system and maintain that, providing two transmitters carry the same programme and have their phases carefully synchronized, the frequency separation between them can be as low as 30-50 kc/s. Taking these two factors into consideration, it would appear that Band II will accommodate all of Europe's v.h.f. stations for a long time to come.

V.H.F. broadcasting requires extensive networks of transmitters to cover large areas of territory. Two obvious methods are microwave links and high-grade music lines. Both of these are expensive and the Germans have avoided this expenditure by the use of two systems known as "Ballempfang" and "Umsetzer." In both methods the station is at once a relay link and broadcast transmitter. With Ballempfang the received signal is demodulated before being fed to the local transmitter. Umsetzer is a frequency-changing device and as such is even more direct. The received signal is converted to an intermediate frequency and this is used to modulate the local transmitter without resorting to demodulation.[3] A number of broadcasting authorities in Europe are, or will be, adopting one or other of these direct re-broadcasting systems because of their obvious advantages. As neither of these systems makes use of any frequencies other than those allocated for the domestic v.h.f. network, it is difficult to understand why the E.B.U. considers that they would considerably complicate the problem of frequency allocations. It is interesting to note an additional use for these v.h.f. networks suggested by Israel and Yugoslavia: that of supplying high-quality modulation to existing medium-wave stations. If eventually, the medium- and long-wave bands can be cleared sufficiently to allow a 10, or even a 12 kc/s channel separation, this system might well be adopted in Western Europe to advantage.

The outlook for v.h.f. broadcasting is distinctly promising, but how will this affect European broadcasting in general? One answer to this question comes from Austria and is worth quoting in full: "Following on the general development of v.h.f. networks in Europe, the conditions necessary for a fruitful revision of the situation on long and medium waves should be established, so that the Austrian medium-wave stations should once again be able to fulfil their function of radiating a national programme, which could also be well received abroad." This statement, which is strongly supported by a number of other countries, is given much prominence in the report under review. However, fears have been expressed that some countries might try to profit by the adoption of v.h.f. by other countries by "pirating" the evacuated channels on medium and long waves.

Both these points were dealt with in the article in the January issue, to which we have already referred. In this an interim plan for medium and long waves was suggested which fits in with the Austrian conception of the future of these wavebands. This article was criticized in a recent issue of the E.B.U. Bulletin[4] on the grounds that the future of European broadcasting on medium and long waves is not known and that, in any case, it would be optimistic to hope to put such a plan into operation by 1960—the date suggested. In view of the opinions expressed in the report and the activity shown by the table to be taking place in the v.h.f. bands, these criticisms seem to be largely invalidated. We can only hope that they are not an excuse for inactivity; it would be a pity to miss such a golden opportunity! We must all, surely, agree with the E.B.U. that the survival of sound broadcasting depends on making the best use of all wavebands and that, in v.h.f., sound broadcasting may even find a new youth.

[3] See "F.M. for B.F.N." *Wireless World*, February, 1956.

[4] March-April, 1956.

New Thermistor Materials

"Rare Earth" Compounds with High Positive Temperature Coefficients

CONVENTIONAL thermistors have negative temperature coefficients of resistance of the order of 5% per degree C and are widely used for the measurement of temperature as well as for current surge suppression in electronic circuits.

For temperature measurement and for other applications where a positive temperature coefficient can be utilized, a new range of materials developed by H. A. Sauer and S. S. Flaschen of Bell Telephone Laboratories is of interest. Basically they consist of barium titanate or barium-strontium titanate with the addition of the rare earth element lanthanum. After suitable processing the materials are electrically and thermally stable over a wide working temperature range, and it is stated that at voltages below which power dissipation does not cause appreciable heating the resistance is "ohmic"; i.e., independent of the applied voltage. Non-rectifying contacts to the new materials are made through the medium of an indium-mercury amalgam.

Performances quoted for typical alternative mixtures are 9%/°C over the range −50°C to 110°C and 14%/°C from 50°C to 225°C.

Electron Tube Information Service

THE U.S. National Bureau of Standards has established a "tube information service" for accumulating and disseminating technical data on both domestic and foreign radio valves. At the present time nearly 10,000 cards, filed by tube type number, are appropriately referenced to manufacturers' source material. In addition, about 10 per cent of these cards, selected mainly from the high-use miniature and sub-miniature types, have been coded on punched cards for mechanical sorting.

With this unique service, it is possible to find (1) information about any particular valve, (2) all valve types whose electrical characteristics, bulb sizes, or base configurations fall within particular ranges, and (3) domestic valves that can be substituted for unavailable foreign valves. Recently, junction diodes and transistors have been added to the Bureau's programme, which began about seven years ago as a service to the Bureau's personnel. It has since been extended to all scientists and engineers in government and industry.

The Bureau's valve information service was established to meet the ever-increasing number of requests for information that was not readily available on little-known valves or those of foreign manufacture. As the service grew, it included more and more detailed information on larger numbers. Recently, the Bureau has begun punched-card coding for automatic selection in order to handle requests more rapidly. The goals of the service are to include all domestic and foreign valve types and to have all information coded.

The service includes all such data on electron tubes and semi-conductor devices as electrical characteristics, bulb size and base configurations, ambient operating conditions and, where possible, constructional details. The main source of this information is the manufacturer's brochure or handbook. While the major companies automatically furnish the information, numerous new and small companies must be queried directly whenever preliminary information on their products is gathered from advertisements, articles and brochures. The Bureau's files include products of about 80 domestic and 15 foreign manufacturers. In general, foreign data has been limited to Western European sources.

Most of the inquiries have been for information about the electrical characteristics of a particular tube type or the selection of a domestic valve for replacement in foreign equipment. Although this sort of request is easily met, questions on cathode operating temperatures or contact potentials must be answered in general terms because these quantities vary with the manufacturer. Queries on valve types with specified electrical, mechanical or geometric characteristics are usually answered by a combination of machine card sorting and reference research. Clearly, only general information can be coded on punched cards; after machine selection of several valves that meet the specifications of the inquiry, reference research is required to supply the more specific information. In general, coding is on the basis of operating voltages, transconductance, etc.; and the valve types machine-selected are those within the ranges specified by the inquiry.

Coding classifications* of valve types for the N.B.S. information service

Function
- power amplifier
- converter
- detector
- voltage regulator
- voltage reference

Emitter type
- coated filament
- thoriated tungsten filament
- tungsten filament
- unipotential, coated
- dispenser
- cold cathode

Normal operating voltages
- grid
- anode

Normal Operting Voltages (Continued)
- screen
- suppressor

Suppressor
- brought out
- tied to cathode

Filament (or heater)
- voltage
- current

Current
- plate
- screen

General Characteristics
- double cathode
- double-ended
- beam power
- sharp cutoff

General Characteristics (Continued)
- remote cutoff
- electrometer
- metal envelope
- guided missile
- hearing aid
- number of electrodes
- physical size
- frequency
- mutual conductance
- amplification factor
- anode resistance
- anode dissipation
- peak inverse voltage
- interelectrode capacitances

*At the present time, punched-card coding has been completed only for miniature and sub-miniature tubes.

RE48:
(Above). Heavy-duty Reflex Horn speaker. Wide-area speech/music diffusion; suitable for parks, swimming galas, all large P.A. systems.

G7822:
(Below). Ribbon mic. of exceptional response and quality. For table or stand use on all indoor locations. Satin-chrome finish and slim appearance.

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RANDOM RADIATIONS

By "DIALLIST"

V.H.F. Receivers

LIKE Stanley May, whose letter on receiver design appeared (appropriately enough!) in the May issue, I'm all in favour of 3-position pre-set tuning in sets made for v.h.f. broadcast reception. Such sets, after all, are used by most people purely for local reception and always for one or other of the same three transmissions. Continuous tuning is therefore not merely unnecessary: it's a darned nuisance. What one wants is to be able to switch on, turn a click-in pointer to one of its three positions and receive the desired programme. In the part of the country where I now live we hope to have v.h.f. in full swing this autumn. There will be something of a rush for receivers when it comes, for on the medium and long waves conditions are so bad that comparatively few people now bother about anything but the news bulletins and an occasional sporting commentary.

More Lines Please

HAVING also seen and admired French 819-line television images, I'm completely with Dr. D. A. Bell (May issue) in feeling most strongly that more lines and wider channels are a more pressing television need than is colour. There's no comparison between a 405-line and an 819-line picture. You can go close up to the screen on which the latter is appearing without being conscious of lininess. That's probably why sets with 21-inch and bigger screens are becoming so popular in France: you can use them in quite small rooms. Then again the 819-line picture pleases the eye owing to the detail it contains. Where we're going to find room for those wide channels I don't know; but where there's a will there's usually a way. I wish I could see an 819-line picture with British engineering skill and studio technique behind it. What a superb product it would be!

Flares and Things

WHAT with his prominences, flares and spots, Old Sol has been playing up long-distance communication services at intervals for some months now. Not only were the wireless services put out of action for hours at a time, but submarine cables also suffered seriously from the effects of earth currents. So far I've seen no reports of what happened to any of the forward scatter services operated in the U.S.A. Dr. J. A. Saxton stated in the January issue* that "the signal does not disappear at times of ionospheric storms and geomagnetic disturbance, indeed it has been suggested that it may even be enhanced." One would very much like to know how things were in the "scatter" link between Goose Bay, Labrador, and Sondre Stromfjord, Greenland, at these times. If its record of over 3½ years of uninterrupted service is still unblemished, the case for v.h.f. ionospheric scattering would seem to be adequately proved.

They Tame 'Em in America

MY suggestion in the April *W.W.* that the line timebases of American television receivers couldn't cause so much interference as some of ours do, since one never found complaints about it in their magazines, brought me a welcome letter from a reader who lives in Baltimore, Maryland. He confirms the correctness of my surmise, telling me that TV set makers in the U.S.A. tame their line timebases so effectively by thorough screening that two receivers can be used within a few feet of one another without any noticeable interference. Actually it's becoming quite usual in America nowadays for there to be two television sets in the home, one for Pop and Mom and the other for Junior and his friends. I trust our manufacturers will provide all their new TV receivers with equally effective l.t.b. screening. It would be a good thing, too, if they could devise screens for some of the existing bad offenders which could be fitted by the dealers who are their agents. One also comes across sets whose line output transformers produce a piercing whistle which is a torture to sensitive ears. My American correspondent mentions that if there is any whistle from the sets of his country, the 525-line scan with 30 images a second makes its pitch so high that most people couldn't hear it.

* "*Ionosphere Scattering at V.H.F.*"; *Jan.*, 1956, *p.* 36.

Television in 1936

WRITING from Horsham, a reader sends me some interesting particulars of the receivers used in the days when the Baird and Marconi-E.M.I.

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systems were being used alternately at Alexandra Palace. He has a service manual for the Marconiphone receiver of the day and here are some points from it. The Baird system was 240 lines sequential with 25 frames a second; the Marconi-E.M.I. 405 lines interlaced with 50 frames. The receiver therefore had to contain switching arrangements so that the timebases could be changed as required from one set of speeds to the other. I remember that much; but one thing I'd forgotten is that the line sync pulses were not sent out during the frame sync period by the Baird transmitter. This tended to allow the line timebase to wander from its proper frequency and was apt to lead to bending of verticals. To counteract this as far as possible an extra MH4 valve was added to the l.t.b. of the receiver.

When Gremlins Chuckle

CURIOUS—isn't it?—how often the completely unexpected snag crops up in the realm of wireless. You'll remember lots of those we encountered in the early years and how difficult it was sometimes to find explanations for them. Of recent days we've had strong interference by French television transmissions with the reception in parts of south-eastern England of B.B.C. pictures—so strong on occasion that bits of the French picture were seen superimposed on the home-produced article. Then, when North Hessary Tor and Pontop Pike went up to full power no one expected that anything but good could come of it. But the gremlins had a nasty little surprise in store. Here's what happened in lots of cases. Two neighbours in the West Country, with aerials mounted on the same chimney stack (or on adjacent ones), had been receiving their pictures from Wenvoe. One of them changed over to North Hessary Tor but the other is content to stay as he is. The man who makes the change gets a fine strong signal; but he also gets strong interference from the other man's l.t.b. The same thing has happened at places in the North when one neighbour changes from Holme Moss to Pontop Pike and his neighbour doesn't. The reason is, of course, that the aerials in question are a good deal nearer to North Hessary Tor (or to Pontop Pike, as the case may be) than to the other station and receive their signals some microseconds earlier. Hence his neighbour's line flyback occurs not during the inter-frame blackout of his set but during the scan.

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MICRO-SWITCH

List Nos. S.690, S.691 (Approx. full size)

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These switches are easily gangable for cam or other operation, and may be mounted on B.B.A. rods, for example. Steady-brackets may be advisable.

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The illustration shows a snailed cam with circular rim taking up some of the relaxed position, and snail (say 40°) giving 1/16in. throw. The 40° should pass in 0.05 sec.

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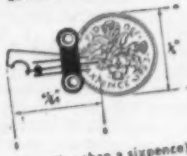

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This tiny, yet robust Open-blade Micro-switch has been designed and perfected by Bulgin of Barking in close collaboration with "Acro-Snap" of U.S.A. Measuring only 63/64in. long x 19/32in. high x ¼in. thick overall it has insulation of finest-grade thermo-setting plastic, with heat treated beryllium-copper alloy blades, and is fitted with heavy pure-silver contacts. Integral solder-tags are finished clean, ready for easy soldering. The maximum frequency of operation is 10 total operations per second. Maximum test voltage, dry or recovered = 1 K.V., maximum, working P.D. across contacts = 250. Rated at 250 V. for 1.0 Amp. Max., peak or surge, at 50~. As can be seen by the illustrations, this miniature component can be ganged, and will fit into equipment where space is restricted. Two models, with alternative pressures:—

List No. S.690—op. at 2-10 ozs.	Max. movement 5/64in.
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FULL technical data is available in the Bulgin catalogue (*Ref.* 195/WW *price* 1/– *post free*). Other Bulgin Micro-switches and components of all types are listed with full information and prices.

BULGIN

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By FREE GRID

Cantuarian Cacologism

HEADMASTERS of our great public schools are invariably men of education and culture and I have little doubt that when the governors of Repton met to choose a successor to Dr. William Temple in 1914 they carefully rejected all candidates whose letters of application made it plain that they were not masters of the King's English.

Since those days the pedagogue whom they chose has "made good" and now serves the country as Primate of All England. Although he is a servant of the Crown he is not, strictly speaking, a civil servant. It is obvious, however, that he is sufficiently near to being a civil servant to have become tainted with the jungle jargon of Whitehall where they cause members of the public to be channelled into national-importancized jobs and subsequently to be hospitalized, coffined and cemeteried.

At any rate since Sir Winston channelled him into the Primacy in 1945, the Archbishop has, linguistically speaking, fallen on evil days. I wonder what he would have said to one of his youthful charges at Repton who had spoken of "religious subjects being *loud-speakered* into restaurants and milk bars," a phrase he used recently. He might at least have said loud-spoken. I hope this latest cacologism will be quickly channelled into the W.P.B. —or should we say dustbinized?

Bodily Batteries

I HAVE had many suggestions as the result of my enquiry in the April issue as to the best sort of primary cell to supply power to a set on a desert island. Let me first thank the many readers who told me that sea water forms a satisfactory emergency electrolyte in a leclanché cell.

Naturally many readers suggested that I should fish for electric eels on arrival at the desert island. However, one of the most interesting things pointed out to me was that the human body itself can be turned into a primary cell. If you run a steel needle into your arm and a spike of some other metal—a pin would do —into some other portion of your anatomy you get a difference of potential between them. The blood is salty and makes a good electrolyte. Probably maiden aunts of ripe years would give the biggest deflection on the meter owing to the greater acidity of their blood.

If enough people are cast away on a desert island, it would suffice to connect them all in series to get a useful h.t. voltage.

Greater acidity

A Musical Jonah

I DARE say that many of my older readers will recall the days when almost every restaurant had its own orchestra steadily churning out popular music in an effort to drown out the nasty noises of the sibilant soup sippers. Just about the time that "Came the Dawn" came no more because the talkies came instead, these mealtime minstrels disappeared from the less expensive restaurants, their places being taken by the canned music distributed by the ubiquitous p.a. system.

I was very sorry about it as I missed the personal touch. But "This 'ere progress, it goes on," as H. G. Wells once wrote, and when I entered a large popular restaurant recently the old personal touch seemed to have come back with a vengeance, but I looked round in vain for the orchestra.

All I could see over the far side of the restaurant was what appeared to be an organist at the manual of an electronic organ. I could not help admiring his skill.

It was not until the sound of a full-bosomed contralto voice came floating over the tables that I realized I had been quite mistaken in thinking that I saw somebody at the console of an electronic organ. I strode hastily across the restaurant to solve the mystery and I saw that the "organist" was indeed responsible for the music but his "keyboard" was a very complicated-looking control desk belonging to the very latest in hi-fi installations.

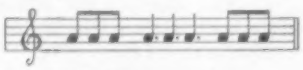
The music was coming from a stereo tape and the control desk just bristled with knobs for bass boost, treble lift and heaven knows what else. During an interval I had an opportunity of talking with the man at the controls. He turned out to be an erstwhile cinema organist. He told me that the control of his switchboard to produce the effects I had heard called for a great deal of musical knowledge and skill.

One interesting point was that he had a specially annotated musical score to assist him. It seems that the wheel has turned full circle and the skilled musician who was swallowed up by the whale of canned music has been regurgitated like Jonah and given a new lease of life.

Secret Service Symphonies

IN a well-known morning newspaper there appears an account of how broadcasting is being used by their friends in Greece to send messages containing information and instructions to the insurgents in Cyprus.

One of the methods used is for the broadcasting station in Greece to radiate a programme of popular music. Thus the orchestra or disc jockey might play "Soldiers of the Queen" followed by "In a monastery garden" and "Three o'clock in the morning," all of which musical items have enjoyed great popularity in their time. The meaning of such a message would be obvious to the most dull-witted of persons but I need hardly add that the code used is not quite so crude.



Try this on your piano

There is nothing new in using the broadcasting of music to get information into or out of an enemy country. One of the most interesting and ingenious methods was that used by the resistance forces in an occupied country during the war. Special musical works were written into which messages in the morse code were interwoven by the simple expedient of juggling with quavers and dotted crotchets, as I reported in these columns in the issue of May, 1942.

If you don't quite get my point I would refer you to the simple little morse message which I give on this page. Try this out on your piano and, unless you are numbered among those few unfortunates who are so unmusical that they only know that the band is playing the National Anthem because men remove their hats and women stop talking, then you should get its meaning.

The beauty of these secret service symphonies was that they could be broadcast in safety even if Hitler himself happened to be in the audience. The messages were all enciphered before they were handed to one of Bach's backroom boys for interweaving into a musical composition so that even he did not know the contents of the message; the conductor and members of the orchestra which churned out the new work merely regarded it as another brainwave of the local Bela Bartok.

OLYMPIC HONOUR FOR BRITAIN

We are proud to announce that our TL/12 amplifiers have been chosen for use in connection with the 1956 Olympic Games to be held in Australia.

It was in 1945 that H. J. Leak revolutionised the performance standards for audio amplifiers by designing the original "Point One" series, and we became *the first firm in the world* to market amplifiers having a total distortion content of 0.1 of 1%. This claim was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and since then hundreds of TL/12 amplifiers have been used by the B.B.C., and Commonwealth and foreign broadcasting authorities, and thousands have been used by recording studios, leading musicians and music-lovers throughout the world. We were the only British exhibitor at the world's first Audio Fair which was held in New York in 1949 and the volume of our exports to the United States of America has grown steadily since then.

Further development work resulted in our producing, at a much lower price but with the same high performance standards, the TL/10 amplifier. The TL/10 amplifier and "Point One" pre-amplifier received such an excellent reception when they were first exhibited at the Audio Fair in New York in October, 1953, that we received an initial order for 1,000 sets. Since then several thousand sets have been sold throughout the world. The output of the TL/10 is ample for high-fidelity home music systems, and the quality of reproduction obtained is equal in every respect to that of the TL/12. We always use the TL/10 amplifier and "Point One" pre-amplifier for our public demonstrations of high-fidelity reproduction of gramophone records and radio. The TL/10 amplifier, when used with the best available complementary equipment, gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price. Even when the complementary equipment falls below that of the best obtainable, the use of these amplifiers will enable one to obtain very marked improvements in reproduction.

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LEAK TL/10 AMPLIFIER, £17. 10. 0.
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A triple loop feedback circuit based on that amous TL/12. The output transformer is the same size as in the TL/12.
Maximum power output: 10 watts.
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Those seeking to obtain the highest quality of gramophone and radio reproduction are invited to ask their dealer for a demonstration of Leak products which, with their tradition of excellence, represent the best that can be obtained.

"POINT ONE" PRE-AMPLIFIER

The handsome gold escutcheon plate contributes to the elegant appearance and blends with all woods.

★ **Pickup**
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

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The radio input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

★ **Distortion**
Of the order of 0.1%.

★ **Hum**
Negligible, due to the use of recently developed valves and special techniques.

★ **Input selector**
Radio, tape, records: any and all records can be accurately equalised.

★ **Treble**
Continuously variable, + 9 db to — 15 db at 10,000 c/s.

★ **Bass**
Continuously variable + 12 db to — 13 db at 40 c/s.

★ **Volume Control and Switch**
The switch controls the power supply to the TL/10 power amplifiers.

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An exclusive feature. Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

ELECTROSTATIC LOUDSPEAKERS

Reprints of "The Gramophone" article (May, 1955) by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

★ *Write for leaflet W* ★

H. J. LEAK & CO. LTD., BRUNEL ROAD, WESTWAY FACTORY ESTATE, ACTON, W.3

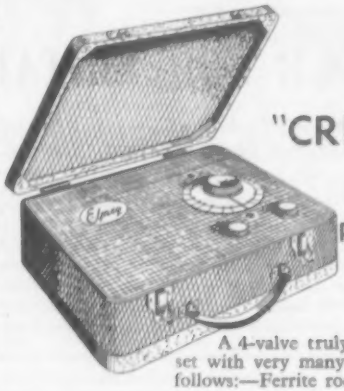
Phone: SHEpherds Bush 1173/4/5 *Telegrams: Sinusoidal, Ealux, London* *Cables: Sinusoidal, London*

OVERCURRENT RELAY

Beautifully made by the famous American Westinghouse Company. These are the surface through panel type with clear Pyrex glass covers. They have coils for remote push button resetting.
Type A—calibrated for currents between .1 and .4 amps.
Type B—calibrated for currents between .5 and 3 amps.
Price, unused and perfect, £3/17/6 each.

MINI-RADIO

Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, £4/10/-, plus 2/6 post. Constructional data free with the parts, or available separately, 1/6.



THE "CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:—Ferrite rod aerials.

- **Low consumption valves.**
- **Superhet circuit with A.V.C.**
- **Ready built and aligned chassis if required.**
- **Beautiful two-tone cabinet.**
- **Guaranteed results on long and medium waves anywhere.**

All parts, including speaker and cabinet, are available separately or if all ordered together the price is £7/15/- complete. Post & insurance 3/6d. Ready built chassis 30/- extra. Instruction booklet free with parts or available separately price 1/6.

EX-ROYAL NAVY SOUND POWERED TELEPHONE

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several telephones are used together will indicate which one is being called. Size 7¼in. × 9in. × 7¼in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc. Price 57/6 each, plus 4/6 carriage.

IMPULSE RELAY

Somewhat soiled due to storage but mechanically O.K. Price 2/6, plus 9d. post. Few new and unused at 5/- each. Booklet giving some circuits price 1/- post free.

MAINLY FOR EXPERIMENTS AND INDUSTRIAL USERS

VACUUM RELAY

American made type No. C61610, this is a relay completely sealed in a glass envelope. It will close in a strong magnetic field or by a coil placed close to or round one of its arms. Price 49/6. Operating coils 25/- each.

WESTINGHOUSE (U.S.A.) METERS

All flush mounting type, outside diameter of face 3¼in.

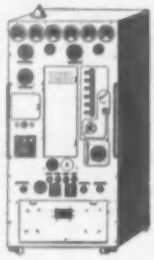
0-500 v. D.C.	25/-
0-1.5 kV D.C. external multiplier	35/-
0-2.5 kV D.C. external multiplier	35/-
0-15 v. A.C. moving iron	30/-
0-1 mA.	25/-
0-50 mA.	25/-
0-100 mA.	25/-
0-150 mA.	25/-
0-250mA	25/-
0-500 mA.	25/-

CONTACTOR

Solenoid operated—completely enclosed in cast iron case, contacts rated at 7.5 amps D.C. —suitable for up to 30 amps. A.C. — coil volts 24 D.C. price 8/- each.

NAVY MODEL TCK-7

Seen at Eastbourne by appointment



We have a few only American transmitters still in original packing cases. Designed for the Navy, these are really beautifully made and most impressive, standing 5ft. high by 2ft. wide and finished in instrument crackle. All meters and controls are on the front panel. The transmitter tunes over the range of 2 megacycles to 18 megacycles and it is designed for high speed precision communication without preliminary calling. Frequency control and stability is particularly good, being better than .005% under the worst conditions. Power output is 400 watts on C.W. and 100 watts on phone. Tuning is very simple—a unit control mechanism—gives a direct reading in frequency.
Complete with valves and instruction manual. Price £95, ex works.
NOTE.—The transmitter will work off A.C. or D.C. with the appropriate power unit. Power units are not available at present.

UNITS FOR CONTROLLED AUTOMATIC ROTATION

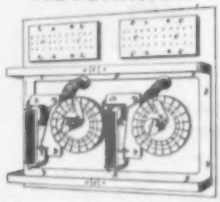
We have brand new, still in original unopened packing cases as shipped from America two items of equipment which form part of the radar system RC84. These two units work together to form a Tower rotating device with remote control.

Item 1, known as Tower 24A, is in fact the geared driving motor which rotates the mast. This is quite a heavy construction and would rotate a heavy scanner, reflector, Beam array etc., etc.

Item 2, known as Indicator 1-221-A is the remote controller which enables the azimuth position of Tower 24A to be controlled from a remote point. Conversely, it enables the azimuth position of the tower to be known at any time. Both the Tower and the Indicator contain relays transmitter/receivers and it is these that provide the impulses which cause the aerial to rotate backwards or forwards. The equipment intended for 117 volt A.C. mains but will operate from our mains if connected through step down transformer of 1 K.W. rating.

Prices 1-221-A £25 plus carriage. TR24A £35 plus carriage.
Special discount of 5% for cash with order or C.O.D. if both units purchased together.

TOWARDS AUTOMATION



Rotary switch—Ministry Ref. No. AP57579, this is a motor driven switch, the driving motor being a synchronous type for working on 110 volts 50 cycles. The two switches have 20 positions each and are enclosed by a Perspex fronted lid. Separately operated relays providing interlocks. Price £4/17/6 each.

RACKING EQUIPMENT

STANDARD OPEN RACK

6ft. high and 19in. wide, heavy steel construction. Holes drilled and tapped at the standardized spacings. Price £3/15/-, plus carriage.

MICA PANELS

Pure mica panels size 2in. × 3in., 3/- per dozen.

GRAMOPHONE AUTO-CHANGER

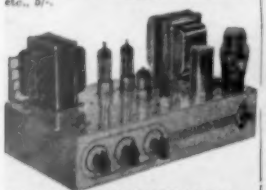
Latest types by all famous makers are invariably in stock at competitive prices. G.E.C., Monarch, Garrard, etc. Latest models from £7/15/0, plus 5/- carriage and insurance.

THIS IS ON OFFER AT APPROX. HALF COST TO MAKE

An impressive costly looking cabinet originally designed for T.V. but simple modification makes the cabinet available for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 22in. deep and 37½in. high. Limited quantity at £8 15/- each, carriage 12/6.

E.H.T. GENERATOR

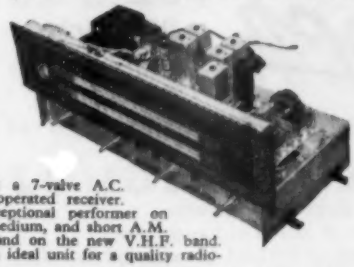
This is a made-up unit, power consumption (6.3 volt 6 amp. filament and approx. 50 mA. H.T.). Contains three BVA valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6½ × 6½ × 7in. Price 60/6, post, packing etc., 5/-.



MULLARD AMPLIFIER "510"

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than .4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is £12/10/-, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

AM/FM RADIOGRAM CHASSIS



This is a 7-valve A.C. mains operated receiver. An exceptional performer on long, medium, and short A.M. bands and on the new V.H.F. band. It is an ideal unit for a quality radiogram.

Special features include magic eye tuning indicator, extra long scale and pointer travel—latest circuitry employing full A.V.C. feedback, etc., etc.

Undoubtedly one of the finest AM/FM chassis available today. Chassis size 17½in. × 6½in. × 7½in. Price £23/17/6, carriage, packing, and insurance 20/- extra.

RECORD PLAYER FOR 84/10/-.

4 SPEED INDUCTION MOTOR

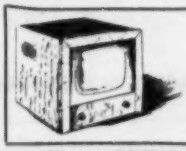
3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side.

HI-FI PICK-UP

Using famous Cosmocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

SPECIAL SNIP OFFER THIS MONTH

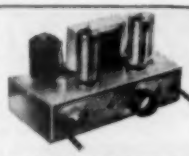
The two units for **£4/10/-**, or 30/- deposit and four payments of 18/-, post and insurance, 5/-. **Or fitted upon base, as illustrated, £5/10/-**, plus 7/6 post and insurance.



14" T.V. CABINET

14in. T.V. cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity—19/6 each. Carriage and packing 3/6 extra.

The "ESTRONIC" BAND III CONVERTER



To-day's best value in Band III converters suitable for your T.V. or money refunded. Complete ready to operate, 59/6 non mains or 85/- mains, post and insurance, 3/6.

HALF-PRICE OFFER

BEETHOVEN CHASSIS

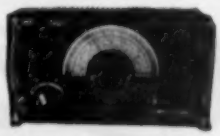
Extremely well built on chassis size approx. 9½ × 7½ × 8½, using only first-class components, fully aligned and tested, 110-240 volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves, frequency changer, double diode triode, pentode output and full wave rectifier. Special cash-with-order price this month, **£5/19/6**, carriage and insurance 7/6. Polished cabinet, 49/6.

NEW CIRCUIT

OCCASIONAL 56—we have evolved a new T.R.F. circuit and have had really good results, equal in fact to many superhets. You really should try this circuit. All parts including valves (6K7, 6J7, 6F6, and 6X5) and Bakelite case with back cost only **£5/10/-**, plus 2/6 post and insurance. Data included with the parts is also available separately, price 2/-.

PLEASE INCLUDE POSTAGE WHEN ORDERING

R1155 YOURS FOR £2



The R1155 is considered to be one of the finest communication receivers available to-day. Its frequency range is 75 kc/s. to 18 Mc/s. It is complete with 10 valves and is fitted in a black metal case. Made for the R.A.F. so obviously a robust receiver which will give years of service. Completely overhauled and guaranteed in perfect working order. Price **£9/19/6** or 5 payments of £2 each. Carriage and Transit case 15/- extra. **Mains Power Pack**, with built-in speaker, **£5/10/-**, or in polished cabinet, **£6/15/-**.

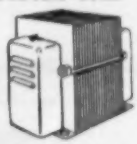
OFFICE TELEPHONES

New G.P.O. telephone sets with internal bell and push button switch easily connected together to form office intercom. Price **£2/10/-** each. Post, etc., 2/6.

TRANSFORMER SNIP

11/6

Post 2/-.



Fully shrouded—standard 200-250 v. primary 250-0-250 at 80 mA., 6.3 v. at 3 amp., 5 v. at 2 amp.

FINE TUNERS

Ceramic trimmers all with ¼in. spindle of fair length. 5, 10, 15, 20, F.F. at **2/3** each or **24/-** per dozen.

CIRCUIT DETAILS

Diagrams and other information extracted from official manuals. All **1/6** per copy. 12 for **15/-**.

American Service Sheets	R.109 76 receiver
A.1134	76 receiver
BC.348	R28/ARC
BC.312	R1116/A
R.103A	RA-1B
B.C.342	AR88D
RA-1B	AN/APA-
R-208	76
R-1155	76
R-1124A	E.T.18
R-1122A/R-1481	CAY-46-AAM-
R-1147	RADAR
R-1224A	A.R.B.-3
R-1092	Indicator 62A
R-1355	Indicator A.S.B.
B.C.1206-A/B	Indicator 62
R-455-A (or -B)	Indicator 6K
R-464-A (or -B)	R.F. unit 24
R-455-A (or -B)	R.F. unit 25
Transmitter T1154; B.D.J.N.	R.F. unit 25 R.F. unit 27
Fifty-eight walkie-talkie	Wireless set No. 19
Frequency meter BC 221	Demobbed valves

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Phone: MAI 4921
Half-day Thursday

42-46, Windmill Hill, Ruislip Middlesex.
Phone: RUISLIP 5780
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Phone: FLEET 2833
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29 Stroud Green Road, Finsbury Park, N.4.
Phone: ARCHWAY 1049
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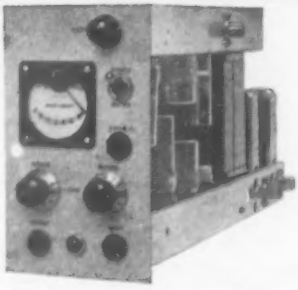
Post orders should be addressed to E.P.E. LTD., M.O. Dept. 2, 123, TERMINUS ROAD, EASTBOURNE.
All enquiries to Eastbourne address and please enclose S.A.E., terms are cash with order.

Reflectograph

Recording and Playback *Units in "BRICK" form*



Frequency Response	50-10,000 cycles ± 2dB 40-12,000 cycles ± 4dB
Signal to noise ratio	50dB
Playback amplifier output level	100 mV (Peak)
Output impedance	10,000 ohms (Unbalanced)
Record amplifier input level	10 mV (For max. Modulation)
Input impedance	500,000 ohms (Unbalanced)
Record Level	By Valve Voltmeter
Playback Output	3 watts into 15 ohms.
Power Requirements	6.3 volts at 2.3A. for Heaters. H.T. 300V. at 75 m/A.

Other input and output impedances can be arranged to special order.

This form of construction, although not new, has not been applied in the field of magnetic recording in so complete a form, as the new units now available.

The "Brick" measures 13½" x 6½" x 3" and is a complete unit housing separate record and playback amplifiers, valve voltmeter record level circuit, bias oscillator and all necessary switching; during playback the record amplifier is switched as a power amplifier and will deliver an output of 3 watts into 15 ohms for connection to a suitable speaker.

The units are available in "split" form, e.g. two playback pre-amplifiers may be used for the playback of stereosonic tape records from a stacked head.

For full information on the Reflectograph Range write to the Manufacturers

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Complete the coupon below and post it to us for further details of the Course which interests you. Write to: Dept. 223E I.C.S., 71 Kingsway, W.C.2

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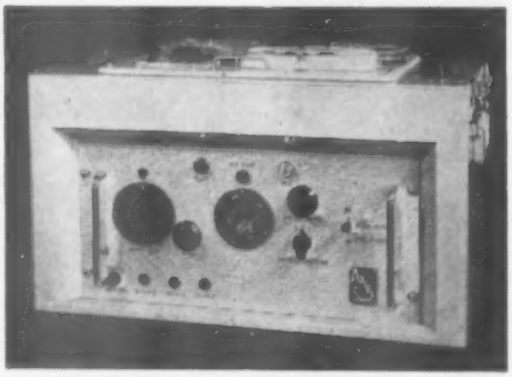

The above shows one of the two units which comprise our new Portable Professional Tape Recording Equipment Type B/WB/1. The following salient features should be noted:—

- ★ **Tape speeds of 15 and 7½ i.p.s. or 7½ and 3¾ i.p.s.; performance at all these speeds to Master Tape standards.**
- ★ **Monitoring from tape or ingoing signal—instantaneous comparison.**
- ★ **B.B.C.-type meter and circuit gives positive indication of audio level, also bias and erase voltages.**
- ★ **Tape inching control for easy editing.**
- ★ **Optional built-in 4-channel microphone mixer.**
- ★ **Complete equipment, including monitor amplifier, self contained in two portable cases.**

Write or telephone for full details, or demonstration (by appointment only please) to:

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Tel. PADington 5092

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12 inch
LOUDSPEAKER UNIT
Type 1255/15

Gives extended audio frequency coverage from 20 to 15,000 c.p.s. with an exceptional performance over the useful audio range.

Ever since the London Audio Fair, where it was received with enthusiasm, our new 12" LOUDSPEAKER UNIT has won for us a stream of complimentary and entirely unsolicited testimonials.

Can we send *you* full details of this new high fidelity speaker unit which—although specially developed for use with quality amplifiers—costs only £9. At the same time we can send you details of Amplifiers used.

GRAMPIAN REPRODUCERS LTD.

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Exact replacement for the R.M.4. 3¼in. fixing centres.
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PLESSEY RANGE of LOPT'S
CP 73833/2. Line output transformers complete with width and linearity controls. Used in Argosy (12in. 1952), Defiant TR 1252, Redfern Stevens (12in. 1952), Regentone Big 12/5, Rentaset (12in. 1952), S.R.M. (12in. 1952), **69/6.**

NURAY Mk. II. A Heater-Booster and Isolator Unit that just plugs in. Gives low emission C.R.T. a new ray. Remedy for tubes with cathode heater short—For 4 and 2 volt tubes. Price **27/6**, p.p. 2/-.

Terms of business: C.W.O., C.O.D. or Pro-Forma. Please add postage and packing (1/6 up to 10/-, 2/- up to £1, 2/6 up to £2. £5 and over p.p. free.)

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AS USED BY BROADCASTING CORPORATIONS THROUGHOUT THE WORLD.

LEAK "TL/10;" AND "POINT ONE" PRE-AMPLIFIER. Cash Price £28/7/-, or sent for **£4/10/-** Deposit and 18 monthly payments of **30/-**, carr. and crate free.

LEAK DYNAMIC PICK-UP
Complete with two detachable diamond heads and transformer. **Cash Price £21/19/9** or sent for **£4** Deposit and 10 monthly payments of **40/-**. Post and packing paid.

Delivery of all the above is from stock. We can also supply the **LEAK F.M. TUNER.** Wharfedale, Goodmans and Tannoy loudspeakers, etc., Connoisseur Variable 3-speed Motors and all other Quality Equipment on EASY TERMS.

Please send us your requirements. Quotation by return of post.

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BALCOMBE (Tel. 254) SUSSEX.

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MOBILE

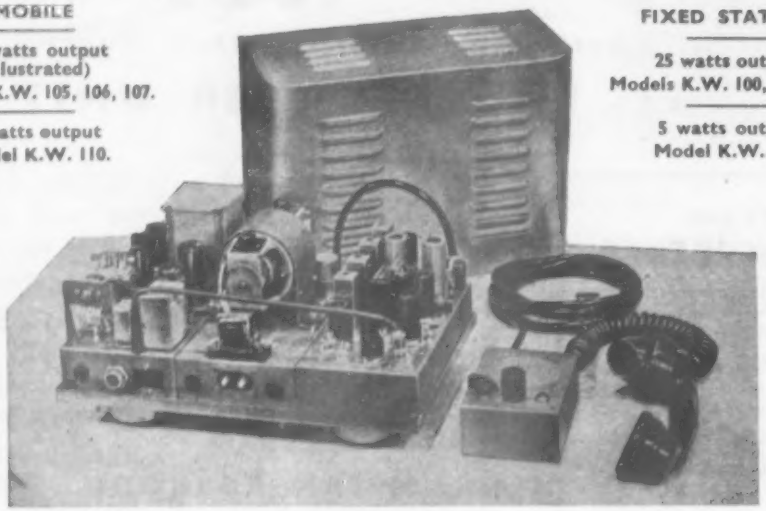
15 watts output
(Illustrated)
Models K.W. 105, 106, 107.

5 watts output
Model K.W. 110.

FIXED STATION

25 watts output
Models K.W. 100, 101, 102.

5 watts output
Model K.W. 112.



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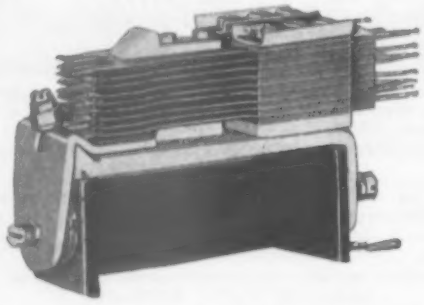
3,000 and 600 relays to specification



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Resistance:
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with test leads

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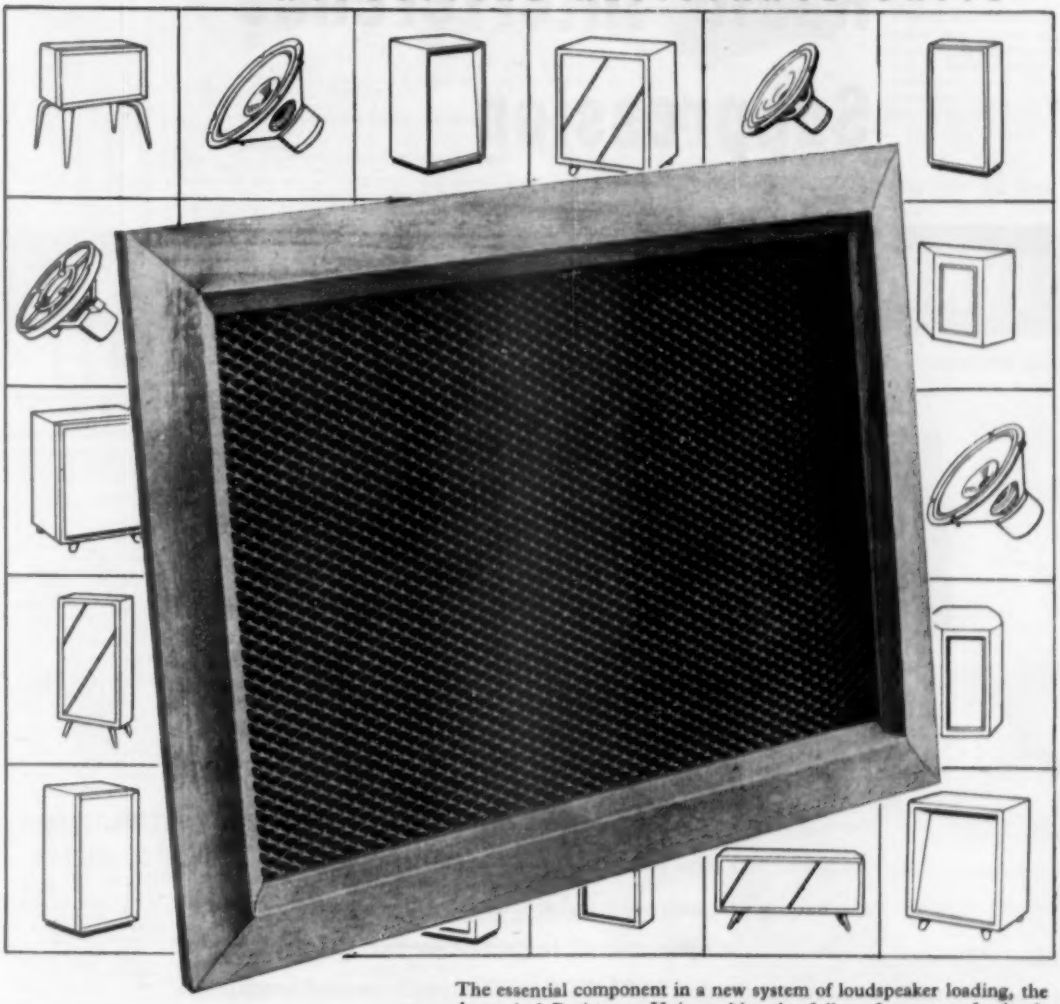
ACOUSTICAL RESISTANCE UNITS



The essential component in a new system of loudspeaker loading, the Acoustical Resistance Unit enables the full performance of a loudspeaker to be realized in an enclosure only two-thirds the volume of a conventional reflex cabinet. Air loading of the cone is fully maintained down to zero frequency.

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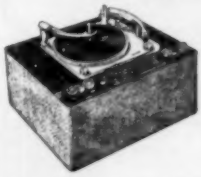

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A superb High-Fidelity instrument incorporating the latest TRUVOX Tape Deck. In a beautifully fitted morocean grained carrying case, this Tape Recorder is the very finest of its class, regardless of price.
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A complete kit consisting of:—
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3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds 3¾in. and 7½in. per sec. Positive Azimuth Adjustment Overall size only 14½ x 12½in. Available for £23/2/-

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Has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Indicator (Operative on Record). A Co-axial Socket is also incorporated for MONITORING on Record, and this can also be used to feed an external amplifier. The Amplifier can also be used for high quality reproduction of gramophone records direct from a gram unit. Available for £14/14/-.

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The **Truvox TAPE DECK** and the **Quality Amplifier** are supplied tested and ready for use, and the actual assembly of the Tape Recorder is extremely simple, involving only a few connections. Step-by-step connection chart is supplied for this purpose.

If you have your own Cabinet WE WILL SUPPLY: **The TRUVOX TAPE DECK, the TAPE AMPLIFIER, MATCHED SPEAKER,** and 1,200ft. of E.M.I. TAPE for £33/10/- plus £1 carr. and ins., 10/- of which is refunded on return of case.

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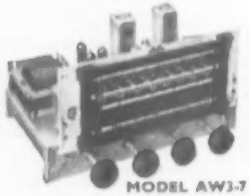
latest 3 SPEED AUTOCHANGERS with modern RADIOGRAM CHASSIS and matched P.M. SPEAKERS at REDUCED PRICES. (H.P. Terms available). A good varied selection. is available . . . SEND S.A.E. for full DETAILS.

TWO REALLY GENUINE PRICE REDUCTIONS

A BULK PURCHASE ENABLES US TO OFFER these RECEIVER CHASSIS at SUCH LOW PRICES. Each is BRAND NEW and FULLY GUARANTEED.

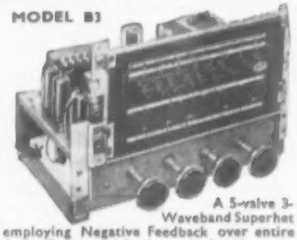


MODEL AW3-7

A 7-valve 3-waveband superhet chassis having a Push-Pull stage for approximately 6 watts output. PRICE **£12-19-6**

H.P. TERMS: Deposit £6/9/6 and 8 monthly payments of 18/9. Plus 7/6 carr. & ins.

MODEL B3



A 5-valve 3-Waveband Superhet employing Negative Feedback over entire Audio Stages and having a single valve type 6BW6 output for approximately 4 watts.

H.P. TERMS: Deposit £5/16/- and 7 monthly payments of 19/3. PRICE **£11-11-0** Plus 7/6 carr. & ins.

THESE THREE CHASSIS HAVE "GRAM" POSITION and are IDEAL REPLACEMENT CHASSIS FOR THAT "OLD RADIOGRAM"—Send S.A.E. for complete details.

THE ARMSTRONG FC48

A high-quality replacement Radio or Radiogram Chassis having provision for an FM Feeder Unit and incorporating separate BASS and TREBLE CONTROLS. PRICE ASSEMBLED and READY FOR USE **£25/2/0**

(Plus 7/6 carr. and insurance.)

TERMS : £6/6/0 Deposit and 9 months o £2/6/0 or £12/11/0 Deposit and 12 months of £1/3/3.

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

STERN RADIO LIMITED

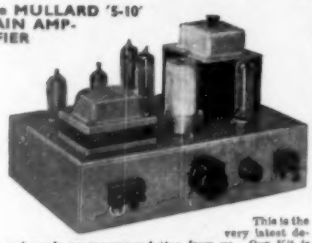
AMPLIFIERS
PRE-AMPLIFIERS

HIGH FIDELITY FOR THE HOME CONSTRUCTOR

TUNING UNITS
RADIO RECEIVERS

—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—

The MULLARD '5-10' MAIN AMPLIFIER



This is the very latest design and needs no recommendation from us. Our Kit is complete to Mullard's specification, including the latest GILSON ULTRA LINEAR OUTPUT TRANSFORMER and the entire MULLARD Valve line up. ALL SPECIFIED COMPONENTS are supplied. **PRICE OF COMPLETE KIT OF PARTS** (Plus 5/- carr. and ins.). **£11/11/0**

THE full SPECIFICATION and BUILDING INSTRUCTIONS for these three Units are available for 1/6 each. THEY include COMPONENT PRICE LISTS and simple "wire-to-wire" PRACTICAL DIAGRAMS.

STERN'S "fidelity" PRE-AMPLIFIER TONE CONTROL UNIT

"A design for the music lover"

Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL. (b) STEEPCUT FILTER, (c) Continuously variable BASS and TREBLE CONTROLS and a variable OUTPUT CONTROL which enables its use with any type of Amplifier.

PRICE OF COMPLETE KIT OF PARTS (Plus 5/- carr. and ins.). WE ALSO OFFER IT ASSEMBLED, READY FOR USE, **£8/0/0** (Plus 5/- carr. & ins.) **£6/6/0**

STERN'S HIGH QUALITY 8-10 WATT POWER AMPLIFIER

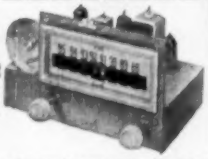
Comprises the MAIN AMPLIFIER of our very popular 8-10 watt design, which we have modified with the express purpose of its use with the "fidelity" PRE-AMPLIFIER illustrated alongside. TWO 6V6's are used in push-pull and the resultant reproduction is genuinely in the HIGH fidelity class, yet the total cost is ridiculously low.

PRICE OF COMPLETE KIT OF PARTS (Main Amplifier only.) (Plus 5/- carr. & ins.) **£7/7/0**

SPECIAL PRICE REDUCTIONS . . . FOR PURCHASERS OF A COMPLETE "Hi-Fi" AMPLIFIER

WE WILL SUPPLY (a) COMPLETE KIT OF PARTS to build THE MULLARD "5-10" MAIN AMPLIFIER and the STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£16/16/-** (plus 7/6 carr. and ins.), or we will supply THE TWO UNITS MADE UP and READY FOR USE for **£19/19/-** (plus 7/6 carr. and ins.). Terms: Deposit **£9/19/6** and 12 monthly payments of **18/7**, or **£5** Deposit and 9 monthly payments of **£1/16/7**.
(b) COMPLETE KIT OF PARTS to build the HIGH QUALITY 8-10 WATT POWER AMPLIFIER and the "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT for **£13** (plus 7/6 carr. and ins.) or we will supply THE TWO UNITS MADE UP and READY FOR USE (less **£15/15/-** (plus 7/6 carr. and ins.). Terms: Deposit **£7/17/6**, 10 monthly payments of **17/9**, or **£4** Deposit and 9 monthly payments of **£1/9/9**.
QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST.

AN F.M. TUNING UNIT for the HOME CONSTRUCTOR



STERN'S "fidelity." A well designed unit that can be completely built for

£10/0/0

A design comprising a 5-valve line up, using the latest type valves and incorporates the MULLARD PERMEABILITY TUNING HEART and a "Magic Eye" Tuning Indicator. The performance of this Tuner is genuinely up to the new standard of similar Units now being offered at about £20. Attractively finished in "Hammered gold." The complete SPECIFICATION and BUILDING INSTRUCTIONS are available for 1/0, "wire-to-wire" Diagrams are included. All Components are available for sale separately. **WE SUPPLY THIS TUNER ASSEMBLED and READY FOR USE.** Terms: Deposit £7/5/- and 9 monthly payments of 18/4, or **£14/10/0** £3/18/0 Deposit and 9 months of £1/5/11.

A design for a **COMBINED AM-FM TUNER** precisely similar in appearance to the above will be available at end of June. The HOME CONSTRUCTOR will be able to build this for **£13/10/-**. It provides complete coverage of the F.M. Waveband, and the MEDIUM WAVEBAND, thereby giving a good selection of foreign stations.

A COMPLETE KIT OF PARTS to BUILD STERN'S "HIGH QUALITY" 8-10 WATT AMPLIFIER

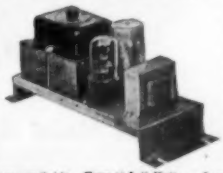
Has power supply available for Radio Tuning Unit.

Price of COMPLETE KIT OF PARTS (plus 5/- carr. and ins.) **£7/10/0**

WE ALSO OFFER IT ASSEMBLED and READY FOR USE for (plus 5/- carr. and ins.) **£9/10/0**

This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The Complete SPECIFICATION and BUILDING INSTRUCTIONS are available for **1/6**.
"Wire-to-Wire" Diagrams are included and all Components are available separately.

STERN'S POWER SUPPLY UNITS



These units are fully smoothed with all output connections terminated to connecting blocks, thereby enabling ease of connecting to a Radio Tuner Unit or Amplifier, etc. Overall size is 9½in. × 5½in. × 4½in. Two Units are available. **Type "A" Unit** . . . Incorporates type 6X5 Valve and provides 250-260 volts at up to 70 m.a. and 6.3 volts at 2½ amps.

PRICE OF COMPLETE KIT OF PARTS ASSEMBLED AND READY FOR USE (Carriage and insurance 2/6 extra.) **£2/9/6 £2/17/6**

TYPE "B" UNIT. . . Incorporates type EZ81 valve and provides 250-300 volts at up to 100 m.A. and 6.3 volts at 2½ amps.

PRICE OF COMPLETE KIT OF PARTS ASSEMBLED AND READY FOR USE (Carriage and insurance is 2/6 extra.) **£2/15/0 £3/3/0**

The WIRING DIAGRAM IS AVAILABLE SEPARATELY FOR 9d.

STERN'S BATTERY PORTABLE for the HOME CONSTRUCTOR

This is a completely NEW DESIGN and we cannot at the time of going to press produce an illustration. It incorporates the NEW "ECONOMY" MINIATURE VALVES, and these have about half the battery consumption of the standard valve line-up normally incorporated in this type of Portable Set—batteries will therefore last about TWICE AS LONG. The Set comprises a 4-valve Superhet design covering both LONG and MEDIUM WAVEBANDS and incorporates a Goodmans 5in. PM Speaker. Tone therefore is very good whilst volume and station selection is excellent. Accommodated in a robust but very attractive resine covered **ATTACHE CASE.**

THE COMPLETE RECEIVER (including ATTACHE CASE) can be built for **£8/12/6**

The **ASSEMBLY MANUAL** which contains "wire-to-wire" diagrams is available for **1/6.**

ALL COMPONENTS are available for sale separately.

The B.S.R. Model TU.8 3-SPEED RECORD PLAYER

Supplied complete, including the new lightweight "Turnover" type Crystal Pick-up, **£4/12/6.**
Or we supply the 3-speed *motor* and Turntable for **£2/15/-.**

STERN'S "COMPACT 5" AMPLIFIERS

EXPRESSLY DEVELOPED FOR VERY HIGH QUALITY REPRODUCTION OF GRAM. RECORDS AND PARTICULARLY SUITABLE FOR HIGH QUALITY REPRODUCTION OF THE F.M. TRANSMISSIONS. TWO MODELS ARE AVAILABLE.

The "Compact 5-2."
A 2-stage high sensitivity amplifier having SEPARATE BASS and TREBLE CONTROLS and designed to give up to approx. 5 watts with very pleasing quality. PRICE **£6/15/-** (plus 5/- carr. and ins.).

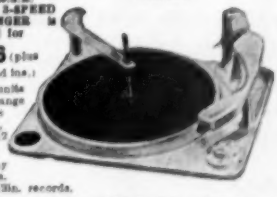
The "Compact 5-3"
A 3-stage version of the "5-2" model, but in this case having an additional stage and incorporating negative feedback. PRICE **£6/16/0.** (plus 5/- carr. and ins.).

The Amplifiers are compact and very attractively designed, having a Bronze/Gold finish with a fully engraved front panel by which the entire Amplifier is conveniently mounted into a Cabinet, occupying no more space than a conventional Tone Control Unit. **Fully described in our Leaflets.**
POWER SUPPLY. A separate small Unit is available and this in addition to supplying power to the Amplifier has additional power available for RADIO TUNING UNIT, etc. PRICE **£2/10/-.**

EXCEPTIONAL OFFER FOR CASH ONLY

This latest B.S.R. MONARCH 3-SPEED AUTOCHANGER is offered for

£7/19/6 (plus 5/- carr. and ins.)



- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in. 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a single switch.
- Minimum baseboard size required 14 × 12½in., with height above 5½in., and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The latest COLLARO RC54 3-SPEED AUTOCHANGER. This is a "mixer" unit and incorporates the "Studio O" Crystal Pick-up. **£9/19/6.** N.F. **£5** dep. and 7 months at **17/2.**

WE ALSO HAVE IN STOCK THE COLLARO MODEL 2010 FX TRANSCRIPTION RECORD PLAYER. S.A.E. FOR FULL DETAILS.

109-115 FLEET ST., LONDON, E.C.4.

Phone: CENtral 5812-3-4.

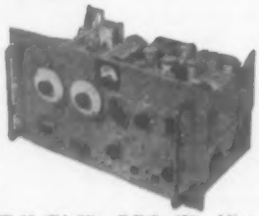
There is always a fine selection of equipment at

2 METRE RECEIVER TYPE R 1382

Air Tested

15 Valve Superhet

Frequency 95-150 Mc/s
(2 to 3 metres)



Valve line up: 1st and 2nd R.F. Amp. VR.136 (EF.54), 1st Local Oscillator VR.65 (SP.61), 2 Oscillator Multipliers VR.136 (EF.54). 3 I.F. Amp. VR.53 (EF.39). A.G.C. 6Q7. Output 6J5. Muting VR.92 (EA.50). Noise Limiter VR.92 (EA.50). B.F.O. 6J7. Mixer VR.136 (EF.54). De Mod. 6Q7.
Slow motion tuning, normally crystal controlled, or tunable over 95–150 Mc/s. Power supply required: 240–250 volts at 80 mA. 6.3 volts at 4 amps. Size 19in. × 10in. × 10in. Standard Rack Mounting. **£6/19/6.** Complete with valves and circuit diagram, checked and Air Tested. *Packing and carriage* 17/6, 10/- *returnable on packing case.*

VIBRATOR PACKS (Mallory)

12V Input 150V 40 mA Size 5½in. × 5¼in. × 3in. Price 17/6 each.
12V Input 275V 80 mA Size 5½in. × 5¼in. × 3in. Price 25/- each.
6V Input 275V 80 mA Size 4¼in. × 6in. × 4¼in. Price 35/- each.
With harness. Plus 2/6 p.p.

LINE TESTING METER UNIT

With one 0–30 mA and one 0–100V 2½in. Panel Mt'g Meters, P.O. Switch, 3 Panel Mounting. Fuse Holders in strong polished wooden case with lined lid and handle. Size 8in. wide × 5¼in. × 5¼in. Price 15/- each. Plus 2/6 p.p.

COMMAND RECEIVERS

BC—453—B 190–500 Kc/s. Price £2/17/6 each.
BC—454—B 3–6 Mc/s. Price £1/5/- each.
BC—455—B 6–9.1 Mc/s. Price £1/5/- each.
Fully Valved—Less Dynamotors (Not New). Plus 3/- p.p.

COMMAND TRANSMITTERS

BC—458—A 5.3–7 Mc/s., BC—459—A 7–9.1 Mc/s. Price £2 each. Fully Valved—Less Dynamotors (Not New). Plus 3/- p.p.

A.R.88. Ceramic Wafered Range Switch Assembly. 8 wafers mounted on chassis measuring 9in. × 9in. × 3½in. Spindle length 15in. Price 17/6. P.us 2/- p.p.

3 c/m WAVEGUIDE

(American) New Flexible and Rigid in lengths from 18in. to 5ft. Also hard bend, easy bend and fittings. *Send for price and details*

PAPER BLOCK CONDENSERS

8 μF 600 V wkg., 5/6 p.p. 4 μF 400 V wkg., 4/- p.p.

P.O. TYPE MAGNETIC COUNTERS

500 ohm reading 0 to 9999. Size 5in. long × 1½in. × 1½in. Price 5/6 p.p.

TYPE 81 MINIATURE TRANSMITTER STRIP

Complete with valves CV.415 (TT15), CV309 (QV04-7), 2-6AM6, 2-BL.91 and Crystal. Circuit supplied Free with unit. Price £4/10/- post paid.

I.F. AMPLIFIER UNIT

460 Kc/s with IT4 Brand New and Boxed. Fully Screened in plug-in Box. Size 2½in. × 1in. × 4½in. Price, with circuit, 10/- ea., plus 1/- p.p.

INSULATION TAPE

Perfect condition. ½in. wide, 25 yd. reels, foiled, in tins, 1/3 each, p.p. 8d.

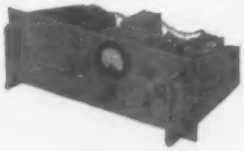
ELECTRO MAGNETIC MICROPHONES

With switch and plug R.A.F. Type 48, new and boxed, 2/- each, p.p.

MAINS POWER UNIT

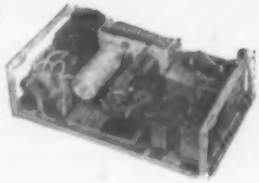
TYPE 234

(For use with Receiver R 1392)

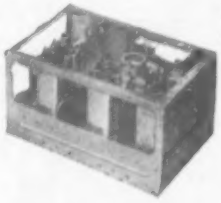


Double Smoothed 200–250 v. 505 Input. 240 V. 100 mA. 6.3 at 6 amps. with Volt Meter reading input and output voltages. Size: 19in. × 10in. × 6½in. Standard Rack Mounting. Price £4/10/- each, plus 7/6 carriage.

POWER UNIT Type 173



12 or 24 Volt D.C. Input 120V, 60 mA. Output. Containing Vibrator Transformer, 12 Volt Vibrator, two 120 Volt Selenium Rectifiers, Chokes and Condensers. Size 10½in. × 6in. × 3in. Price 12/6, post paid.



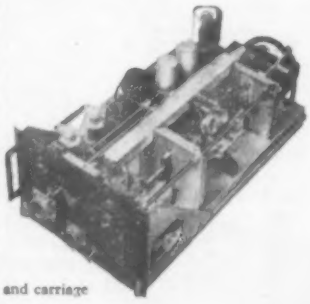
RECEIVER UNIT Ex 1143A

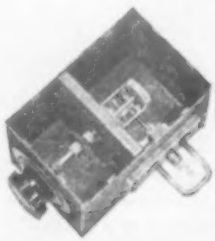
Suitable for conversion to 2 metres or F.M. Wrotham transmissions.

Valve line-up: (4) EF50. (1) EL32. (2) EF39. (1) EBC33. (1) BA50. Supplied with circuit diagrams.
Fully valved 35/- each, plus 5/- p.p.

A.P.Q.9 RADAR JAMMING UNIT

Containing 913A Photo Multiplier Cell, complete with resistance network and lightproof box. Wide band amplifier (2) 6AC7 and 6AG7, driving a pair of parallel 807s which Grid modulate a pair of 8012s in push pull. Lecher lines, these cooled by blower motor. Cathode loaded by Co-axial stubs which simultaneously guillotine tune anode and grid lines with a counter mechanism. Output is matched to aerial by a matching stub. Suitable for use in centimetric bands. Brand new, price £5, plus 10/- packing and carriage





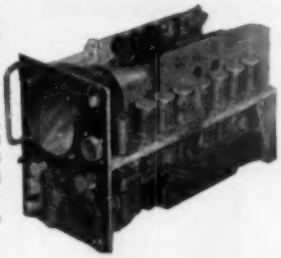
ABSORPTION WAVEMETER

Easily converted to 2 metres or 70 cm. In Copper-plated metal case 3½in. × 4½in. × 5½in. with dial calibrated 0-100 and 80 V Neon Tube. Coverage approx. 190-210 Mc/s. New, 6/6 each, post paid.

All these fine offers are on display at →

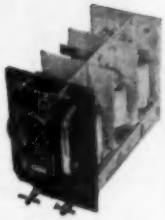
PROOPS BROS. LTD. — *The Walk-around Shop*

TYPE 62A INDICATORS



Ideal for conversion to oscilloscopes, T.V. units, etc. Containing V.C.R.97, 12 VR.91 (EF.50), 2 VR.54 (EB.34), 3 VR.92 (EA.50), 4 CV.118 (SP.61). Slow-motion dial, 13 Pots and scores of useful components. Size: 8½ × 11½ × 18in. In wooden packing case, £3, carriage 7/6.

R.F. UNITS



R.F.24 20-30 Mc/s. Switched Tuning. Valved. 9/6 each.

R.P.25 40-50 Mc/s. Switched Tuning. Valved. 9/6 each.

R.F.26 50-65 Mc/s. Variable Tuning. Valved (new and boxed) 25/- each.

Packing and postage 2/- each.

2-3mA MEASUREMENT METER

2-3 mA movements in metal case measuring 4½in. high, 3½in. wide and 5in. deep. 7/6 plus 2/- p.p.

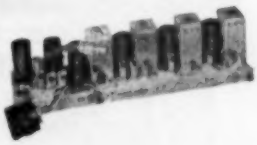
THROAT MICROPHONES

Type TS30. U.S. Manufacture.

Complete with elastic strap. Lead terminating at 2-pin plug PL.291, and socket JJ-048. New and boxed, 3/- each, post paid.

INSULATION TAPE. Perfect condition, ½in. wide 25-yd. reels foiled in tins, 1/3 each, p.p. 8d.

MINIATURE I.F. STRIPS



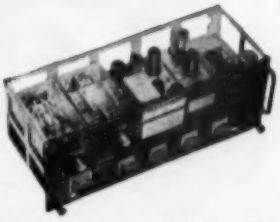
Size 10½ × 10½ × 3in. Frequency 9.72 Mc/s. 2 EF.92s and 1 EF.91. I.F. amps. EB91. DET/AGC. EF.91 AGC. Amp. and EF.91. Limiter. Circuit supplied.

Price : 8/- less valves

Post paid.

AN/APN1 UNITS

R.F. TRANSMITTER



A sub-chassis 3½ × 6½ × 2½in. containing a R.F. Transmitter operating 67.42 cm. (445 Mc/s) with a bandwidth of 40 Mc/s. Modulation of its carrier is by means of a Moving Coil Transducer with a metal diaphragm. The proximity of the diaphragm effectively changes the resonant frequency of its tuned circuit, to produce frequency modulation. This transmitter utilises TWO 955 (VT 121) valves, and can quickly be converted for Radio Controlled Models; the frequency for this purpose being in the band, or for 70 cm. work.

Price, post paid, **15/-**

RECEIVER

A sub-chassis 3½ × 6½ × 2½in. houses a Receiver tuned to the transmitting frequency. Contains TWO 9004 valves. For use in 70 cm. band.

Price, post paid, **12/6**

A.F. AMPLIFIER

An Audio Frequency Amplifier in a sub-chassis 5 × 3 × 3½in. R/C coupled, using TWO 12SH7 and ONE 12SJ7 valves; and can be used for Telephone Intercom., Pre-Amplifiers, etc.

Price, post paid, **15/-**

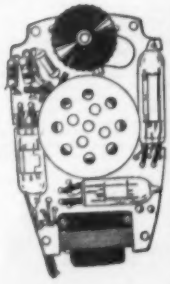
SENSITIVE ALTIMETERS

0-45,000 feet. Suitable for climbers, Gliders and Car enthusiasts. In working order. Price 15/- each, p. and p. 3/-.

BENDIX I.F. Transformers. 1.63 Mc/s complete in cans, set of two new and boxed. Size 2 × 1½ × 3½in., 5/-, p.p. 1/6.

BENDIX Potted Audio Output Transformer complete with integral smoothing choke. Ratings 4½ watt 9,000 ohm Primary, 600 and 4,000 ohm Secondary. Size: 4 × 1½ × 2in. New and boxed, 4/6, p.p. 1/6.

Make a miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

Technical Details. A Germanium Diode Detector circuit followed by the existing 3 valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

SEE and HEAR this Miniature POCKET RADIO demonstrated.

THE COMPLETE KIT OF PARTS includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature ear phone and moulded ear insert attached; ferrite rod, germanium diode, components, circuit diagram and full instructions.

Price **£2 6s. 0d.** Post paid

ALL COMPONENTS SOLD SEPARATELY

Dear Aid Unit with earpiece..	£1	15	0
Plastic Ear mould.....		2	0
Ferrite Rod		5	0
Conversion Components.....		4	0
Batteries 1.5 v. L.T. (Type D.18)			8
30 v. H.T. (Type B.119)		4	3

NOTE: As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

NOTE: Carriage prices quoted apply only to England and Wales.

NOTE: Orders and Enquiries to Dept. "W" Shop hours 9 a.m. to 6 p.m.—Thurs.: 9 a.m. to 1 p.m.

PROOPS BROS. LTD. OPEN ALL DAY SATURDAY. *Telephone : LANgham 0141*

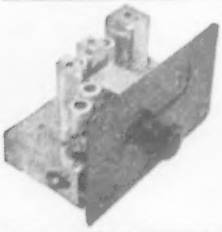
52 TOTTENHAM COURT ROAD, LONDON, W.1

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1.

MUSeum 5929/0095.
(50 yards only from Tottenham Court Road Tube !)
All post orders please to:—24-26, HAMPSTEAD RD., LONDON, N.W.1
EUSton 5533/4/5

TELSTRON BAND III CONVERTOR! Still available, this very popular convertor kit as illustrated and fully described in previous issues of the "W.W." For use with most T.R.F. or Superhet Band I T.V. Receivers. Construction details only, with separate individually priced parts list 6d. post free. Kit complete as specified 49/6, plus 2/- P. & P.
Mk. II Fringe area version kit complete 59/6, plus 2/- P. and P. Power pack kit for either of above 25/-.
We carry comprehensive stocks of all Band III Convertors by leading manufacturers. Also aerials, cross-over boxes, air-spaced low-loss co-axial cable at 10d. per yard. Let us have your enquiries. Any branded convertor supplied on H.P. terms!

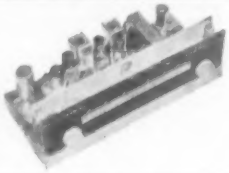


THE JASON F.M. TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s., and attractive bronze escutcheon enamelled (front plate already mounted (illustrated). Front plate size 8in. × 6in., chassis 7in. × 4¼in. × 1¼in. Complete standard kit £6/15/- plus 2/6 p. and p. Fringe area kit £7/15/-, plus p. and p.

THE T.S.L. F.M. TUNER!

We can now supply this FM/VHF adaptor either in kit form, or fully assembled, wired and tested. Our price for the ready-built unit which incorporates its own power supply, is £13/15/- only tax paid, plus 5/- P. & P. or H.P. terms. Magic eye tuning indicator, just plug in, 16/- extra. Or the kit complete as specified £10/19/6 plus 3/6 P. & P. The booklet "F.M. TUNER CONSTRUCTION" (32 pages) with full technical data and point-to-point wiring diagrams, together with our separately priced parts list, is available at 2/6 post free.



THE T.S.L. AM/FM CHASSIS!
Exceptional value. Covers L.M. and S.W. plus F.M.! 8-valve push-pull output. Ferrite rod aerial. Valve line-up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6s plus 5y3. Large full-vision dial, size 14¼ × 6in. Chassis size, overall: 18 × 7¼ × 9in. high. Tax paid 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, complete with escutcheon and fixing cable at 26/-. H.P. terms available. Demonstrations at 18 Tottenham Court Road!

THE DULCI F.M. TUNER. Incorporates own power supply, suitable for use with any amplifier. Valve line-up: ECC85, two EF89, EABC80, 6 × 4, and EM80 Indicator! Overall size: 9 × 6 × 8½in. high. Pre-Budget price £16/16/- plus 2/-. P.P. Illustrated leaflet available, also H.P. terms.

SPECIAL OFFER!! Champion Model 835 FM/VHF Adaptor! Designed for the instant conversion of A.C. radiograms, table A.M. receivers and Hi-Fi audio amplifiers, to enable owners through their existing equipment to obtain the best results from the new F.M. transmission. Two connections only. One to the A.C. mains supply, the other to the pick-up sockets. Valve line-up: EF85, two EF80s, EB91, and EZ80. In attractive red and cream bakelite cabinet. Illustrated leaflet available on request. Price whilst stocks last only £13/19/6 tax paid, plus 3/6 P. & P. H.P. terms available.

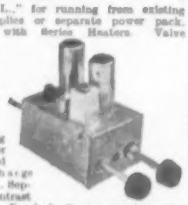
DENCO F.M. TUNER. This highly successful kit is still available at inclusive price of £6/7/6 plus 2/6 P. & P. This kit includes all components and the five valves required for the extra I.F. stage for fringe area reception. If required, "Denco" dial and drive assembly is available for the above at 9/- extra. Full constructional details 1/6 post free.

F.M. POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuners or any other similar type. Price for the complete kit is 37/6 only, or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 × 6 × 1¼in. Optional extra for power pack: Bulgin Getal Plug 2/3.

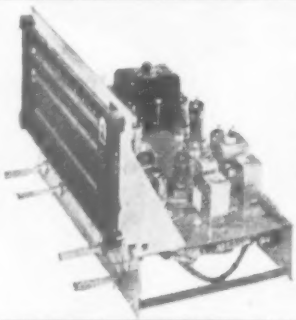
THE R.S.P. 1-VALVE RECEIVER. All dry battery operation, for use with headphone. The complete kit is available at 42/-, plus 2/- P. & P., or full instructions at 9d. post free.

COMPETITIVE!! BAND III. CONVERTORS!

Type "M.L." for running from existing power supplies or separate power pack. Available with Series Heaters. Valve line-up: PCC84 and PCF80. Size: 4 × 3¼ × 4¼in. Fitted with external fine tuning control for Band 3 and Band 1/3 change over switch. Separate contrast control for Band 3. Power requirements H.T. 150/250 v. at 30 mA., L.T. 15/16 v. .3 amp. (Series Heaters). Unit simply fitted inside cabinet. Complete with handsome escutcheon. Available for A.C. operation with parallel heaters, ECC84 and ECF80 as above. Price £4/12/6. P. & P. 2/6. Full instructions supplied with each unit. Please specify whether for London, or Birmingham, or Manchester.



THE FAMOUS UNIVERTER—COMPARE THE PRICE!
Handsome walnut cabinet. Suitable all areas. Contains own power supply. Simply connect to aerial. Four-valve circuit. Complete with all instructions £6/19/6 plus 3/6 P. & P.



AM/FM RADIOGRAM CHASSIS! BARGAIN!

A special purchase of strictly limited quantity enables us to offer the following! For Medium, Long and F.M. Wavebands, plus gram position . . . Chassis size overall 13¼in. long, 9in. high, 7¼in. deep. Dial which is attractive red, green and gold lettering, on black background, measures 12in. × 5¼in. horizontal. For A.C. mains, 200/250 v. Valve line-up KL84, EABC80, EF85, ECH81, ECC85, EZ80, plus EM80 Magic Eye!! Limited quantity at bargain price of £18/19/6 only, plus 5/- P. & P. H.P. terms.

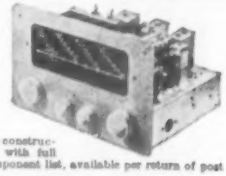
DULCI AM/FM CHASSIS H4

Illustrated leaflet available. L.M. and Short Waves plus F.M. This is a quality chassis 6 latest B.V.A. Mullard Valves, including magic eye. High Q. inductances throughout, also Ferrite rods. Price is £27/16/- cash—or H.P. terms.

DULCI AM/FM TUNER

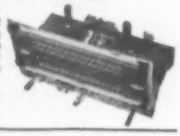
Just released. Details available. Price £24 including tax, or H.P. terms.

AM/FM KIT! FIRST AGAIN!



Introducing the JASON AM/FM KIT for medium waves and F.M.!
As illustrated this is a very high quality chassis incorporating 6 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £15/5/-. Also less output stage but with own built-in power pack at £13/19/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list, available per return of post at 1/6, post free. Both plus 3/6 P. & P.

SPECIAL PURCHASE! MANUFACTURER'S SURPLUS



Owing to favourable purchase, we can offer strictly limited quantity of these handsome chassis. AC/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line-up: U107, N108, DH107, W107 and X109. Overall chassis size 12 × 5½ × 7¼in. high. Attractive bronze dial with gold and cream lettering. Dial size 11½ × 4¼in. Scale length 7¼in. Logging scale provided. Price £7/19/6 only, tax paid, plus 3/6 P. & P. H.P. terms. £4 deposit plus four monthly payments of 32/-.

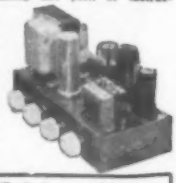
THE R.C. GRAM REPLACEMENT CHASSIS KIT.

Still available. Our very popular Gram Chassis replacement kit. For long, medium and short waves, and provision for gram. Valves 6K8, 6K7, 6Q7, 6V6 and 6X5.

For A.C. Mains 200/250 v. Chassis size: 13½in. × 8½in. × 3½in. Dial size 10¼in. × 4¼in. Assembly is simplified by use of ready assembled coil pack. Illustrated booklet with full assembly instructions, with itemised price list, is 1/6 post free—or the kit complete to last nut and bolt at £8/8/- plus 3/6 P. & P.

THE R.C.2/4 WATT AMPLIFIER KIT.

Just released! Compare the advantages! Treble bass, AND middle controls! For crystal or magnetic pickup! A.C. Mains 200/250 v. Valve line-up, 6V6GT, 6SG7, metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 6in. × 1¼in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book fully illustrated, for 1/-. Post free. This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus p. and p. Hearing is believing.

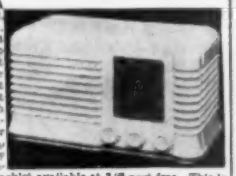


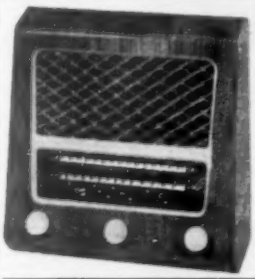
ACOS TYPE 7 Crystal Microphone Inserts. Brand new, 7/6 each, post free.

Our advantageous H.P. terms are available on any single item over £5. Let us have your enquiries.

Please add postage under £1, or Cash with order. C.O.D. charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry but we close 1 p.m. on Saturday.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price **£5/10/-** complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at **1/6** post free. This is allowed if kit is purchased later. Plus 2/6 packing and carriage for complete kit.





THE "SUPERIOR" FOUR KIT. Our new four-valve receiver. A.C. mains, 200/250 v. M. and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6SG7, 6 X26T and 6 V6GT. Chassis ready drilled. Cabinet size, 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at **1/6** post free. Our price for complete kit, **£6/9/6**. Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at **45/-**, plus 2/6 packing and carriage. **N.B.**—Our kits are even supplied with sufficient solder for the job.

N.B. All our T.R.F. Kit circuits now include specially wound Denco "Maxi-Q" coils on polystyrene formers, improved performance! Price remains the same.

SURPLUS BARGAINS

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamps	D.C. 2in.	M.C.	R.F.	50/-
50 microamp	D.C. 3½in.	M.C.	F.R. (Tropicalised)	85/-
50 microamp	D.C. 5in.	M.C.	Rectangular	190/-
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3½in.	M.C.	F.R.	95/-
100 microamp	D.C. 2½in.	M.C.	F.R.	45/-
200 microamp	D.C. 2in.	M.C.	F.R. (Tropicalised)	35/-
200 microamp	D.C. 3½in.	M.C.	F.R.	65/-
500 microamp	D.C. 2in.	M.C.	F.R.	18/6
1 mA.	D.C. 2in.	M.C.	F.R.	17/6
1 mA.	D.C. 2in.	M.C.	F.Sq.	22/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1954 manufacture by Elliott)	25/-
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
5 mA.	D.C. 2in.	M.C.	F. Sq.	10/-
30 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
500 mA.	D.C. 2in.	M.C.	F.R.	10/6
5 amp.	R.F. 2in.	Thermo	F. Sq.	6/6
1 amp.	R.F. 2½in.	M.C.	F.R.	10/-
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.F.	45/-
1 amp.	R.F. 2½in.	Thermo	R.F.	7/6
3 amp.	R.F. 2in.	Thermo	F. Sq.	7/6
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
20 amp.	D.C. 2in.	—	R.F. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.R.	6/6
30 amp.	D.C. 2½in.	M.I.	F.R.	12/6
15 volt	A.C. 2½in.	M.I.	F.R.	10/-
20 volt (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.R.	17/6
300 volt	A.C. 2½in.	M.C.	F.R.	35/-
300 volt	A.C. 3½in.	M.I.	F.R.	30/-

2½in. **ROUND FLUSH MOUNTING METE** L by **WESTON**, blank scale ready for re-engraving, FSD 650 microamps, brand new, **27/6** only.

SPECIAL. U.S. 0-1 mA. 2½in. taken from equipment but perfect, **22/6** each. R.P. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.R. = Flush Round. M.I. = Moving Iron.

METER RECTIFIERS, 1 mA. by G.E.C., at **6/6**, also 5 mA. by G.E.C., at **6/6**.

COMMUNICATION RECEIVER PCR.3 3-wave band, 13-50, 190-570, 900-2,000 metres. Valve line-up 6V6, EBC33, X61 and 3-EF.39. Illuminated calibrated dial, fly-wheel tuning, aerial trimmer. In black crackle case size 17½in. × 16in. × 9in. Output socket for 3 ohm speaker, or headphones. Absolutely brand new in original cartons, manufactured for Govt. by PYE LTD.

Price **£7/10/-** only, plus p. and p. 10/-. With each set we supply full conversion details for A.C. mains. All required components for conversion available at **30/6** post paid. Limited quantity.

We can now supply already converted ready for A.C. Mains at **£9/19/6**, plus carriage. H.P. available.

METER SPECIAL! We have a limited quantity of aircraft electrical thermometers. Brand new, by Weston. 2in. moving coil meter, flush square fitting. These meters have a luminous scale graduated 40-140 degrees centigrade, but the full scale deflection is approximately 100 microamps. Price **12/6** each only, plus 1/- P. & P.

VIBRATOR PACK. Brand new, by Mallory 12 volt input, 150 v. 40 mA. output. Complete with synchronous vibrator, **17/6**.

COIL PACKS. Manufacturers' Surplus. Miniature size, only 2½in. × 2½in. × 1½in. deep. Iron-cored. For L.M. and S.W. with gram. position. Switch has 2-inch spindle. Absolutely brand new, complete with aircuit. Price only **27/6**, plus 1/6 P. & P. A snip!

AMERICAN INDICATOR UNIT TYPE BC929A. Brand new incorporating 2in. tube 3BP1, with mu-metal shield, 3-6BN7GT 2-6H6GT, 6X5G, 2X2, 6G6G, 9 potentiometers 24 v., transformer, and a host of small components. The whole unit which measures only 8¼in. × 6¼in. × 13½in. is brand new, enclosed in black crackle box, and can be supplied at **45/-**, plus 5/- p. & p.

No. 38 TRANSMITTER/RECEIVER WALKIE-TALKIE. Range approx. 5 miles. Coverage 7.4-9 Mc/s. The set only complete with valves at **25/-**. In very good condition.

We also have available "38" sets, absolutely complete with junction box, aerial, headphones, microphone, spare set of valves, with full operating instructions, absolutely brand new in original sealed packing cases, at **99/6** each complete station, plus 5/- carriage. Export enquiries invited.

POWER PACK. By leading manufacturer. Input 200/250 v. Output 350-0-350 280 mA., 6.3 v., 5 a., 6.3 v. 2 a., 4 v. 7 a., 5 v. 2 a. Fully smoothed. Incorporates valve rectifier GZ32. Chassis measures 13in. × 7in. × 8½in. Wt. 22lb. Few only at **£4/19/6**, plus 3/6 p. and p.

THE R.C. RAMBLER ALL-DRY PORTABLE KIT

Full assembly details with practical and theoretical diagrams can be supplied at **1/6** post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attache-case type cabinet; measuring only 9in. × 7in. × 5½in. Weight less batteries 4½lb., with batteries 6½lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of **£7/7/-** plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at **10/-**. Also L.T. 1.5 v. A.D. 35 at **1/6**.

RAMBLER MAINS UNIT. At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits snugly into battery compartment, can be supplied at 47/6 plus 1/6 packing and postage. Price includes all required components and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 3½in. × 1½in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

B.S.R. MONARCH. The very latest cream 3-speed mixer Auto-changer. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only £7/19/6. Buy now! Quantity at this price strictly limited.

JUST ARRIVED! Replacement pick-up cartridge for B.S.R. Monarch, etc., type BGP 37. Complete with sapphire stylii, fitted in few seconds. Limited quantity at **18/6** only! Tax paid, post free!

BC.54. Special Purchase! Latest type 3-speed, incorporating "T" type turnover head. Cream finish. Original manufacturer's cartons. **£9/19/6** only, plus 3/6 p. and p. H.P. terms available.

RECORD PLAYER CABINETS. Specially made to house any type of single record unit. Finished in dove-grey leatherette. Baseboard measures 14½in. × 12½in. Clearance above and below board 3in., **45/-** plus 3/- P. & P. We can also supply equally attractive dove-grey cabinet to house any standard auto-changer at **69/6** plus 5/- P. & P. We carry a large selection of cabinets for all purposes. A stamp will bring illustrated cabinet leaflets.

R.F. UNITS. All new condition and complete. Case size 9½in. × 7½in. × 8in. Type 24, 20-30 Mc/s. **8/6**. Switched Tuning. Type 25, 40-50 Mc/s. **10/6**. switched Tuning. Type 44, 90-95 Mc/s. switched Tuning, **12/6**. ALL these units Post Free.

EX-W.D. CATHODE RAY TUBES. Guaranteed full picture. VCR97 at **40/-**, VCR517C at **35/-**. Also VCR139A—Ideal for oscilloscope 2½in. screen at **35/-**. We also have VCR97 with slight cut-off very suitable for oscilloscope, testing purposes, etc., at **15/-** only. All these tubes are brand new, in original packing, and tested before despatch. Please add 2/6 packing and carriage for any of the above tubes.

MAINS TRANSFORMER BARGAINS. Limited quantities. Manufacturers' Surplus. 350-0-350, 60 mA., 6.3 v. 3 a., 5 v. 2 a. Half shrouded, drop-through, **14/6** only, plus 1/6 P. & P. 250 v. input, 300-0-300 80 mA., 6.3 v., 3 a., 4 v. 2 a. Tropicalised drop-through type, **9/6** only, plus 1/6 P. & P. Input 110/230 v. Auto load 250 v. 750 mA., 350-0-350 130 mA. Tapped filament winding 6. v. 3 a., 15 v. 3 a., 21.5 v. .6 a., also 5 v. 2 a. Tropicalised drop-through type, **21/-** plus 2/6 P. & P. 270-0-270, 100 mA. 6.3 v. 3 a., 6 v. 2 a., 200/250 v. input universal mounting **16/6**, plus 1/6 P. & P.

6-VOLT VIBRATOR PACK. Ex-W.D. 6-volt input, output 140 v. 30 mA. Fully smoothed and rectified, incorporating Wearite 6 volt 4 pin vibrator type S.816. Unit size only 6½in. × 5in. × 2½in. Price **15/-** plus 1/- P. & P. New condition.

RECEIVER TYPE 88/73. (The receiver section of TR1196). Supplied complete with full data for conversion to 3-wave superhet receiver. Unit is complete with 6 valves 2-EF36, 2-EF36, FK32 and EBC33, also standard I.F.T.'s 465 Kc/s. Price **27/6** plus 2/6 P. & P.

TR1196 TRANSMITTER PORTION. We can also supply the transmitter portion of the above receiver incorporating valves, EL32, EF50, CV301. Type 600 relay transformer, coils, switches, etc. Limited quantity at **12/6** only, plus 2/6 P. & P.

VALVES

We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection only of brand new imported valve types, fully guaranteed. Purchase Tax Paid.

EABC80	10/-	DAF96	10/6	FLA3	11/6
EAF42	10/-	DF96	10/6	PY80	10/6
EB41	7/6	DK32	10/6	PY81	10/-
EB91	7/6	DK96	10/6	PY82	9/6
EBC41	10/-	DL96	10/6	PY83	11/6
EBF89	11/6	or **35/6** per set		UBC41	10/6
ECC81	9/-	of four.		UCH42	11/6
ECC82	9/-	DM70	9/-	UF41	10/6
ECC83	9/-	EL41	10/6	UL41	10/6
ECC84	15/-	EL84	11/6	UY41	9/-
ECC85	10/-	EM80	9/-	6AQ5	8/6
ECF82	15/-	EY51	12/-	6AT6	8/-
ECH42	11/6	EY86	14/6	6AU6	9/6
ECH81	11/6	EZ40	8/6	6BA6	8/6
ECL80	11/6	EZ80	8/6	6BE6	9/-
KF41	10/6	PCF80	12/6	6BW6	8/6
KF80	10/6	PCF82	12/6	6X4	7/6
KF85	10/6	PCC84	12/6	35W4	7/6
KF86	12/6	PL81	13/6	50B5	10/-
KF89	10/-	PL82	10/6	50C5	10/-

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list!

BRAND NEW C.R. TUBES.—By leading manufacturer, 12in. equivalent to MW 31/74 **£11/19/6**. MW36/24 Tinted. Latest type 14in. rectangular 6.3 v. heater. 19-14 Kv. in original sealed cartons. Limited quantity only at **£12/19/6**. Ditto 17in. type 17ASP4. Price **£15/19/6**. All H.P. available. Plus 15/- packing, carriage and insurance.

TRANSISTORS' MULLARD TYPE OC.71. Available ex stock at new list price of **84/-** each, post free

Another Cabinet Bargain! Special purchase of walnut veneered trolley-type cabinets originally intended for use in projection T.V. Easily recognised as being of leading High Quality manufacturer's stock, heavy dark solid walnut. Can be easily adapted to house tape recorder, amplifier, radiogram, etc., etc. Measurements external 24½in. × 16in. × 29in. The whole is mounted on castors. Unrepeatable bargain at **£5/19/6**, plus 10/- packing and carriage. We have a large selection of all type cabinets. A stamp will bring list.

CLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1.

R.S.C. BATTERY CHARGING EQUIPMENT

All for A.C. MAINS 200-250 v., 50 c/cr Guaranteed 12 months.

ASSEMBLED CHARGER
6 v. or 12 v. 2 amps.
Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused.

Only **46/9** carr. 3/6.

ASSEMBLED CHARGERS
6 v. 1 amp. 19/9
6 v. or 12 v. 1 amp. .. 25/9
6 v. 2 amps. 29/9
6 v. or 12 v. 2 amps.. 38/9
6 v. or 12 v. 4 amps.. 56/9
Above ready for use. Carr. 2/9

HEAVY DUTY KIT
12 v. 30 amp. Suitable for Garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers. 2 Meters, 4 Fuses, 4 Terminals, 2 Rheostats and circuit. Only 9 gns., carr. 15/-.

BATTERY CHARGER KITS
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.
6 v. or 12 v. 1 amp. 22/9
6 v. 2 amps. 25/9
6 v. or 12 v. 2 amps. .. 31/6
6 v. or 12 v. 4 amps. .. 49/9

BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and variable charge rheostat with knob. Only 45/9. Post 3/-.

Assembled 6 v. or 12 v. 4 amps.
Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 3/6. **69/6**

SELENIUM RECTIFIERS

L.T. Types		6/12 v. 6 a.	19/9
2/6 v. ½ a.h.w...	1/9	6/12 v. 10 a.	25/9
6/12 v. ½ a.h.w.	2/9	**H.T. Type H.W.**	
F.W. Bridge Types		120 v. 40 mA....	3/9
6/12 v. 1 a.	5/9	250 v. 50 mA....	5/9
6/12 v. 2 a.	8/9	250 v. 80 mA....	7/9
6/12 v. 3 a.	12/9	250 v. 150 mA.	9/9
6/12 v. 4 a.	16/9	300 v. 275 mA.	12/11

CO-AXIAL CABLE. 75 ohms ½in., 8d. yard. Twin screened feeder, 11d. yard.

5 CORE FLEX. Henleys circular rubber 14/36. Each lead colour coded. 1/6 yd.

T.V. CABINETS. For 15, 16 or 17in. tube. Table model with doors, 79/6, carr. 7/6. Table type for 12in. Tube 27/6, carr. 5/6. All leading manufacturers surplus.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF), .002 mfd. (2,000 pfd.). All at 6d. each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz. 6.5 v. 0.3 a., 6/9 doz.

ELECTROLYTICS (current production). NOT Ex-Govt.

Tubular Types		Can Types	
8μF 450 v.....	1/9	8 mfd. 350 v...	1/3
8 mfd. 500 v.	2/6	8 mfd. 600 v...	2/11
16μF 350 v.....	2/3	16 mfd. 350 v...	1/11
16μF 450 v.....	2/9	16μF 450 v.....	2/9
16μF 500 v.....	3/9	16 mfd. 500 v...	3/9
32μF 350 v.....	3/9	32μF 350 v.....	2/11
32 mfd. 350 v...	5/9	32 mfd. 450 v...	4/9
32 mfd. 500 v...	5/9	100 mfd. 450 v.	4/9
8-16μF 500 v...	4/11	8-8μF 450 v ..	2/9
25μF 25 v.	1/3	8-16μF 450 v...	2/11
50μF 12 v.	1/3	16-16μF 450 v.	3/11
50 mfd. 25 v....	1/9	16-32μF 350 v.	4/9
50μF 50 v.	1/9	32-32μF 350 v.	4/9
100 mfd. 12 v...	1/9	32-32μF 450 v.	5/9
100 mfd. 25 v...	2/3	64-120 mfd. 350v	7/6
		100-200 mfd. 275 v.	6/11

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

VIBRATORS. Oak 2 v. 7 pin. synchronous, 7/9.

EX GOVT. E.H.T. CONDENSERS
.5 mfd., 2,500 v. Blocks 3/9
.5 mfd. 3,500 v. Cans 3/3
1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated) 9/6

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v. ..	1/9	10 mfd. 600 v.	6/9
4 mfd. 500 v. ..	2/9	8-8 mfd. 500 v.	5/11
8 mfd. 500 v. ..	5/9	15 mfd 500 v...	7/9
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137, EA50, EB34 11d., SP61 2/3; 4SHA 1/3; EL32 3/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G etc., trans., L.F. choke, Rectifier etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at 29/9. Carr. 7/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob 2 S.P.S.T. switches, various plugs and sockets. Only 1/6.

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt. surplus, only 5/9 each.

EX GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s. input.
8.8 v. 4 a., 9/9. 120-0-120 v. 40 mA. 5/9
300-0-300 v. 150 mA. 4 v. 3 a. 9/9
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. Potted 4½-3½-3in. 11/9
460 v. 200 mA., 6.3 v. 5 a. 22/9
0-16-18-20 v. 35 a. 79/6. Carriage 5/- extra.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a., 5 v. 3 a., 33/9. Clamped type 250-0-250 v. 70 mA., 6.3 v. 2.5 a. 9/9, post 1/9.

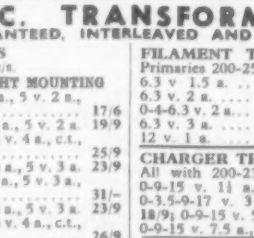
EX GOVT. SMOOTHING CHOKES

250 mA., 10 H., 50 ohms	14/9
250 mA., 3 H., 50 ohms	8/9
150 mA., 10 H., 50 ohms	10/11
150 mA., 6-10 H., 150 ohms., Tropicalised	6/9
100 mA., 10 H., 100 ohms, Parmeko	6/9
100 mA., 10 H., 200 ohms, Tropicalised..	3/11
50 mA., 50 H., 1,000 ohms	6/9
L.T. type 1 amp., 2 ohms	2/9

SPECIAL OFFERS. Small 2 gang variables .0005 mfd., 4/9. 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, 1/6 ea.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/cs. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams 39/9, or ready for use, 46/9.



Type BM2. Size 8 x 5½ x 2¼in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS.** When connected to A.C. mains supply 200-250 v. 50 c/cs. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit of parts with diagrams and instructions 49/9, or ready for use 59/6.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS. (15 ohms), consisting of a high quality 12in. speaker, of orthodox design supporting a smaller elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A8 or any similar amplifier. Rating is 10 watts. Price only £5/17/6.

MAINS ENERGISED SPEAKERS R.A. 2-3 ohms. 8in. Field 600 ohms., 10/9. 10in. Field 1,500 ohms., 23/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in. 17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. 19/9
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. 25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion 31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
300-0-300 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. 26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier 33/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a. 26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. 33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. 33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a. c.t., 5 v. 3 a. suitable Williamson Amplifier, etc. 49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a 69/6

TOP SHROUDED DROP-THROUGH TYPE
250-0-250 v. 70 mA., 6.3 v. 2.5 a. 13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. 16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. 18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. 23/9
350-0-350 v. 100 mA., 6.3 v. 4 a. c.t., 5 v. 3 a. 22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a. 23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. 29/9

E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 ..... 36/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v 1.5 a. ..	5/9	0-2-4-5-6.3 v.	
6.3 v. 2 a.	7/6	4 a.	16/9
0-4-6.3 v. 2 a...	7/9	6.3 v. 6 a.	17/6
6.3 v. 3 a.	8/11	12 v. 3 a. or	
12 v. 1 a.	7/9	24 v. 1.5 a. ..	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9, 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 v. 3 a., 17/9; 0-3.5-9-17 v. 4 a., 18/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9; 0-9-15 v. 7.5 a., 28/9.

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.
120 v. 40 mA., 5-0-5 v. 1 a. 14/9
90 v. 15 mA., 6-0-6 v., 250 mA. 9/11

OUTPUT TRANSFORMERS
Midget Battery Pentode 66 : 1 for 3S4, etc. 3/6
Small Pentode, 5,000Ω to 3Ω 3/9
Standard Pentode, 5,000Ω to 3Ω 4/9
Standard Pentode, 8,000Ω to 3Ω 4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull 5/6
Push-Pull 8 Watts 6V6 to 3 ohms 8/9
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω 15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω 16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms ... 21/9
Push-Pull 10-15 Watts, Ultra Linear, designed for Mullard Amplifier 510 .... 39/6
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω 47/9
Williamson type exact to spec. 85/-

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms.	11/9
150 mA., 7-10 H., 250 ohms.	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms.	5/6
60 mA., 10 H., 400 ohms.	4/11

R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

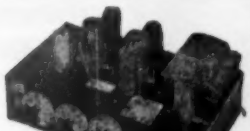
NEW 1956 DESIGN. HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 30 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to-follow wiring diagrams. Only **9 GNS.** Carr. 10/-

Or Factory built with 12 months' guarantee, 50/- extra. **H.P. TERMS ON ASSEMBLED UNITS: DEPOSIT 28/6 and 12 monthly payments of 21/-.** If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. Extra cost for this 13/-. Cover as illustrated 17/6 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.**

We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on H.P. terms with amplifiers.

EXPORT ENQUIRIES INVITED



R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER

FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox, etc. Chassis size 15-7-3in. Overall size 12-7-6½in. For 230-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response ± 2 D.B. 60-11,000 c/cs.

11 Ready for use. **GNS.** Carr. 7/6

Facilities for recordings at 15in., 7½in., or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. **PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST.** LEAFLET 6d.

GARRARD 3-SPEED AUTOMATIC RECORD CHANGERS. Latest Model. Type RC110. Fitted high fidelity turnover crystal pick-up head. For 200-250 v. A.C. mains. Limited number. Brand new cartoned. Only **£8/17/6**, plus 5/6 carriage.

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). 3-speed 331 r.p.m. **BRAND NEW. CARTONED.** Only **£9/19/6** (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type, 55/-. Piezo with heavy floor base and telescopic stem, **£6/10/6.**

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible, being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-**, or assembled ready for use **£5/-** extra, plus 3/6 carriage.

R.S.C. A73-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3/15/-**, carr. 5/6 or factory built **22/6** extra.

BRAND NEW B.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal pick-up and dual point sapphire stylli for standard or long playing records. Plays ten 7in., 10in., or 12in. intermixed. For A.C. mains 200-260 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions. **£7/15/-** plus 3/6 carr.

WALNUT VENEERED CABINETS. Designed for above record changers with provision for housing amplifier and speaker. Attractive design. Limited number. Brand new cartoned **£3/19/6**, carr. 7/6.

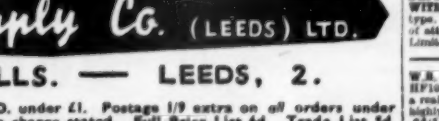
QUALITY AMPLIFIERS. 3-4 watt, specially designed for use with B&R changer and above cabinet. Latest miniature type valves used. Separate Bass and Treble Controls and Vol. Control with mains switch. For A.C. 200-250 v. mains. Ready for use, only **£3/19/6**, carr. 3/6.

P.M. SPEAKERS. Suitable for use with above equipment. Elliptical 7 × 4 7in. with 2-3 ohm speech coil, **18/6** ea.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. Low impedance with matching trans., brand new, boxed at fraction of normal price. Only 31/-.

P.M. SPEAKERS. 2-3 ohm., 5in. Goodmans, 17/6, 6½in. R.A., 15/9, 8in. Rola, 19/9, 10in. R.A., 26/9, 12in. Plessey, 39/11.

THE SKY FOUR T.R.F. RECEIVER



A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, 6P61, 6V6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of **£4/19/6** including cabinet. Available in brown or cream bakelite, veneered walnut.

ROTARY CONVERTERS. 150 watts. Input 12 v D.C. Output 230 v. 50 c/cs. A.C. Only **7 gns.** Carr. 7/6.

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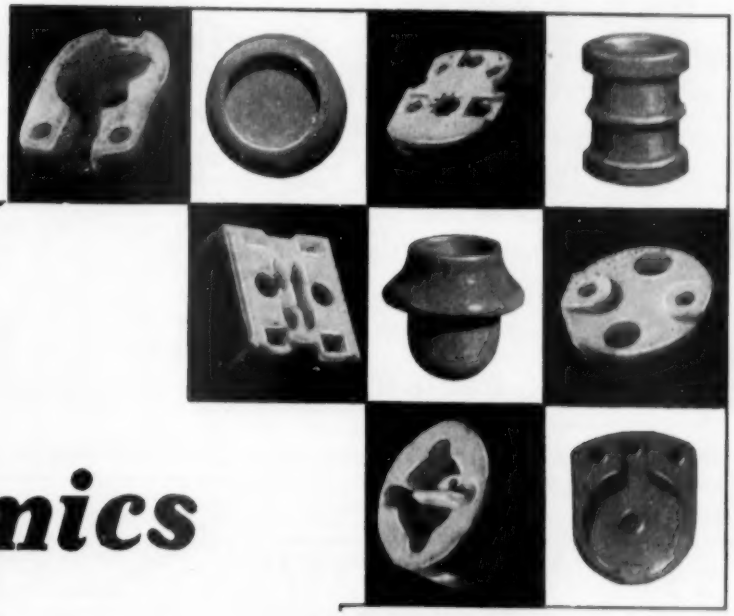

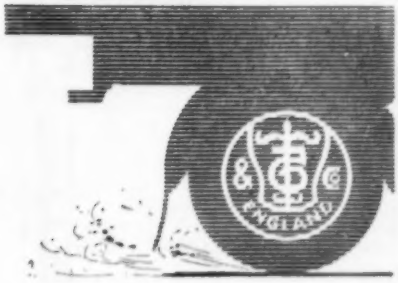

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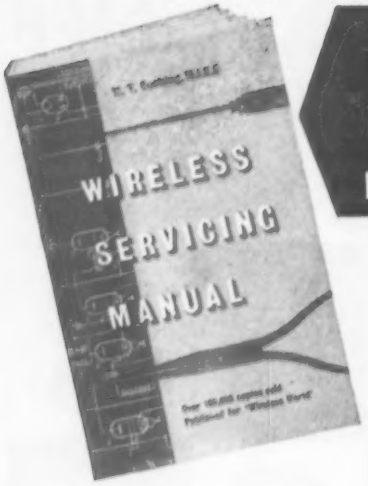

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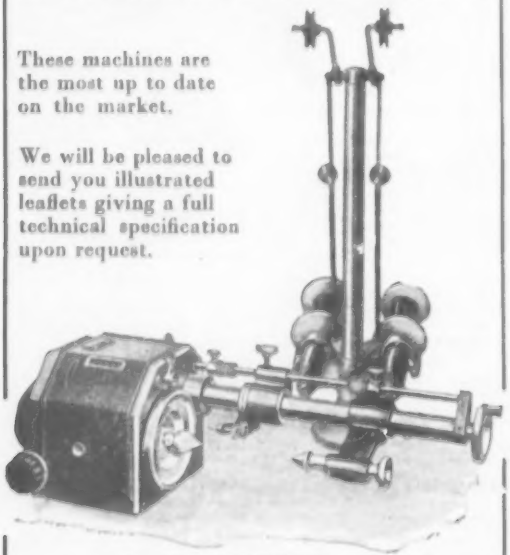

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Secondary: 30 v. 2 amps.
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230 v. Input Tapped 6-12 v. 1 amp., as. 13/6
230 v. Input Tapped 6-12 v. 3 amp. (Both with tap on Primary for 2.5 v. Pilot light), each 18/-

HEATER AUTO TRANSFORMERS
Designed to adapt common low to mains voltages 4 v., 5 v., 6.3 v. at 3 amps., centre tapped and interchangeable, each 7/9

WIRE WOUND CONTROLS
By Colvern, etc., all with ¼in. spindle. 5 ohms, 100 ohms, 200 ohms, 350 ohms, 500 ohms, 1K ohms, 5K ohms, 10K ohms, 20K ohms, 25K ohms and 50K ohms. All 2/6 each.

G.E.C. CABINET LOUDSPEAKERS, Cat. No. BC1956
6in. P.M. moving coil loudspeaker unit, 3/4 ohms with volume control in very attractive cabinet. Price 52/6 each, post 2/6.

CONDENSERS

BEC 100 MFD 25 v.	1/9
BEC 500 MFD 12 v.	1/6
TCC 25 MFD 25 v.	1/3
DUBILIER 100 MFD 12 v.	1/9
BEC 50 MFD 50 v.	1/6
TCC 25 MFD 50 v.	1/9
TCC 50 MFD 25 v.	1/9
TCC 250 MFD 12 v.	1/6
BEC 250 MFD 25 v.	1/6
BEC 12 MFD 50 v.	1/-
TCC 50 MFD 12 v.	1/6
BEC 250—250 MFD 6 v.	1/6
DUBILIER 50—12 MFD 12 v.	1/9

OUTPUT TRANSFORMERS

Multi Ratio Type, each	6/6
Midget for 3S4 Output, each	4/6
Standard 5,000 ohms, each	4/6
Standard 10,000 ohms, each	4/6
Ignanic Jack Plugs, each	6½
Bell Lee 7-pin Plug and Socket, each	1/9

CHARGER RECTIFIERS—All Full Wave

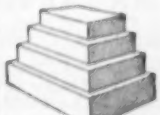
12 volt 1 amp., each	5/3
12 volt, 2 amps., each	6/6
12 volt, 3 amps., each	13/6

VOLUME CONTROLS
Type with Single Pole Switch.
5K ohms; 10K ohms; 20K ohms; 50K ohms; 100K ohms; ½ meg.; ¼ meg.; 1 meg.; 2 meg. All 3/6 each.

DUAL VOLUME CONTROL
With Double Pole Switch 500K ohms and 500K ohms. Price 6/9 each.

CHASSIS . . . Aluminium Unrifled with Reinforced Corners.
Available in the following sizes:

6in. x 4in. x 2½in., each	4/6	12in. x 8in. x 2½in., each	5/6
8in. x 6in. x 2½in., each	6/3	14in. x 9in. x 2½in., each	6/-
10in. x 7in. x 2½in., each	7/5	14in. x 9in. x 3½in., each	12/-
12in. x 8in. x 2½in., each	5/9	16in. x 6in. x 2½in., each	8/6
12in. x 8in., 2½in., each	6/9	16in. x 10in. x 2½in., ea.	14/-



All are four-sided—ideal for radio receivers—amplifiers—power packs, etc.

TYANA SOLDERING IRON
Lightweight 40 watt iron, with easily replaceable elements and bits. 200/250 v. price 16/9 each.

TRANSFORMER MT6
Small mains transformer suitable for TV converters, etc. Primary 230 v. Secondary 200 v. 40 M/A and 6.3 v., 1.5A. Price 15/6 each. Postage 1/6.

PURETONE TAPE
1,200ft. Reels, Plastic Spool. 17/6 each.

LOUDSPEAKER UNITS—all 2/4 ohms
5in. types by Goodmans, Rola, Lectrona, Ruffette etc., all ..... 17/6 each
6½in. types by Goodmans, R. & A., Plessey, etc., all ..... 18/6 each
8in. types by Goodmans, Plessey, R. & A., etc., all ..... 19/6 each
10in. types by Celestion, R. & A., Plessey, etc., all ..... 25/6 each
12in. types by Plessey, light weight unit ..... 35/- each
Goodmans 4in. x 7in. elliptical speaker ..... 19/6 each
8in. suite with output transformer by Goodmans and Lectrona ... 22/6 each

MAINS ENERGISED TYPES
8in. 650 ohm field, 21/- 6½in. 800 ohm field, 17/6.
Postage on all above 1/6 extra.

A NEW ALPHA KIT FOR YOU TO BUILD

Suitmaker Portable, AC/DC Mains/Battery Receiver, 4 valves (latest types), 2 wave-band Superhet in an attractive lizard grey case size 8½" x 8½" x 4½". Full kit of parts down to last nut and bolt. **£9.9.0**

Or if you prefer you can build the battery version first for £7.17.6 and add the mains components later. Post extra on kit 2/6.

Full circuit diagram, shopping list and point-to-point wiring diagram 2/6.

WHEN ORDERING PLEASE QUOTE DEPT W.W.

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5/6 VINCES CHAMBERS
VICTORIA SQUARE
LEEDS 1.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/-; unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

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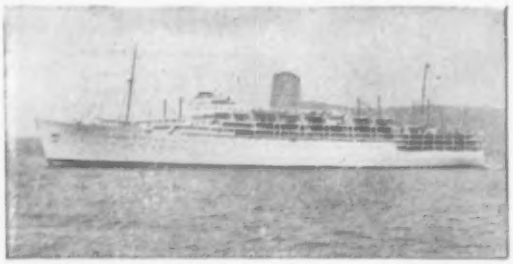

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Spectone
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The magnetic tape reproducing equipment installed in these luxury liners was selected after due consideration was given to the outstanding specification and performance. Write for full technical specifications of single channel and stereophonic reproducers, amplifiers and pre-amplifiers.

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MAGNETIC SOUND HEADS

HALF TRACK HEADS AVAILABLE:

Model 5RP Record/Play Head	£3 5 0
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Model 5R Record Head (Used in conjunction with 6RP head)	£3 5 0
Model 5E Erase Head	£3 5 0
Commercial "friction" type mounting stems	4/- extra

Standard Heads—High Impedance, Low Impedance Heads and Special Heads made to order.

SCREENING CANS:

All Mumetal	8/6 each
Composite (Steel/Mumetal)	4/6 each

We specialise—that is why deck manufacturers standardise our heads.

STEREOPHONIC HEADS:

Suitable for use with the new Stereosonic pre-recorded magnetic tapes. Price £14/10/- each.

Model 5 range of desks to take 7in., 9½in. or 10½in. Reels. Push-button control—three heads—two speeds—three motors

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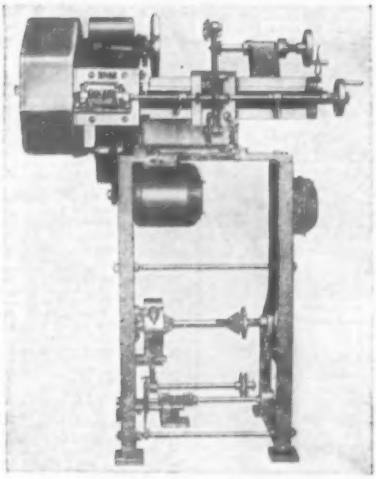

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DIAMETER OF COIL 10" · LENGTH OF COIL 12"
WIRE GAUGES 10 TO 30 S.W.G PRICE £150

AUTOMATIC AND HAND COIL WINDING MACHINES
ETA TOOL CO. (LEICESTER) **LTD**
DEPARTMENT NO. 1
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C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit or for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1 : 1.25 giving a 25% boost on Secondary.

2 volt	10/6 each	With Tag
4 volt	10/6 each	Panel and
6.3 volt	10/6 each	Solder Tags
10.8 volt	10/6 each	
13.3 volt	10/6 each	

Ditto with mains primaries 12/6 each.
Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.5, 10 and 13 volts. Input has two 'tap' which increase output volts by 25%, and 50%, respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 220/240 volts. Output 2-1½-2½-3 volts at 2 amps. With Tag Panel 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. receivers having series connected heaters.

RESISTORS. All values. 10 ohms to 10 meg., ½ w., 6d.; ¼ w., 6d.; ½ w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w., 1%, 2/-. All preferred values 100 ohms to 10 meg.

½ watt	WIRE-WOUND RESISTORS	1/3
10 watt	25 ohms—10,000 ohms	1/6
15 watt		2/-

15,000 ohms—50,000 ohms, 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS. 2 WATT LAB. COLVERN ETC.

Pre-set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/- Ditto Carbon Track 50 K. to 2 Meg. 3/-	Standard Size Pots., 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100K., 6/6.
	W/W EXT. SPEAKER CONTROL 19Ω 3/-.

O/P TRANSFORMERS. Heavy Duty 60 mA., 4/6. Multi-ratio, push pull, 6/6. Tapped small pentode, 3/9. Hygrade Push Pull 7 wts. 15/6.
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/30 H. 100/120 mA., 11/6; 30/15 H. 120/150 mA., 12/6; 5 H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 4.3 v. tapped 4 v. 4 a., 5 v. tapped 4 v. 2 a., ditto 250-0-250 60 mA., etc., 21/-.

I.F. TRANSFORMERS. 465 kcs. Pye Radio, midget size 2½in. × ¾in. × ¾in., 7/6 pr. With data sheet.

HEATER TRANS. Tapped 200/250 v. 6.3 v. 1½ amp., 7/6.
COPPER PLATED AERIAL RODS. ¼ × 12in. push fitting, 1/- doz., Post 1/-.
ALADDIN FORMERS and cores. ½in., 6d., ⅝in., 10d. ¾in. **FORMERS** with Can and Core. ¾in. sq. × 1½in. and ⅞in. sq. × 2¼in., 2/- ea.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYARA. Midget Soldering Iron. 200/230 v. or 230/250 v., 14/11.
SOLON MIDGET IRON. 25 w., 24/-.
MIKE TRANS. Ratio 50 : 1, 5/9 ea., new and boxed.
MAINS DROPPERS. 9 × 1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .3 amp., 1,000 ohms, 4/3.
LINE CORD. .5 amp. 80 ohms. per foot, .2 amp., 100 ohms per foot, 2 way 6d. per foot, 3 way 7d. per foot.

CRYSTAL MIKE INSERT. By Acos, precision engineered. Size only 1⅛ × 3/16in. Bargain Price, 6/6. No transformer required.

LOUDSPEAKERS P.M. 3 OHM.
5in. R.A., 17/6. 7in. × 4in. Goodmans, 21/-.
6½in. Goodmans, 18/6. 8in. Elac, 22/6.
6½in. ditto w/Trans., 21/-. 10in. R.A., 30/-.
12in. Plessey, 30/-.
8in. M.E. 2.5 k. or 2 k. field, tapped O.P. transf., 24/6.
CRYSTAL DIODE. G.E.C., 2/-. GEX34 4/-.
CRYSTAL SET CONSTRUCTION, 1/-.
40 CIRCUITS USING GERMANIUM DIODES, 3/-.
H.R. HEADPHONES, 4,000 ohms. Brand new, 17/6 pr.
SWITCH CLEANER Fluid, squirt spout. 3/9 tin.
TWIN GANG TUNING CONDENSERS. .0005 mfd. midget with trimmers 8/6; 375 pf. midget less trimmers 6/6; .0005 Standard size with trimmers and feet 9/-; less trimmers 6/-; ditto, solled, 2/6. Cossor 3-gang 509pf., 7/6.

PURETONE RECORDING TAPE

1,200ft. on standard fitting 7" Plastic reels. Brand new boxed 17/6 Spools 5" metal 1/6, 7" plastic 4/3

VALVE HOLDERS. Pax Int. Oct. 4d., EF50, EA50; 6d. B13A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/-
MOULDED Mazda and Int. Oct. 6d., B7G, B8A, B9G, B9A, 9d. B7G with can 1/6. **VCR97 2/6.** B9A with can, 2/6.
CERAMIC. EF50, B7G, Int. Oct. 1/-, B7G with can, 1/9.
SPEAKER FRET. Woven Plastic **TYGAN.** Walnut tone. 12in. wide, 2/- per foot. Expanded metal, gold, 9½in. × 12in., 2/- per piece. Silver 18½in. × 9½in., 2/-.
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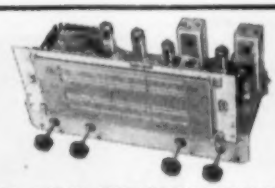
2 p. 5-way, 3 p. 2-way, short spindle	2/6
3 p. 4-way, 3 wafer, long spindle	6/6
2 p. 6-way, 4 p. 2-way, 6 p. 3-way, long spindle	3/6
3 p. 4-way, 1 p. 12-way, long spindle	3/6

KNOBS. GOLD ENGRAVED. Walnut or Ivory, 1½in. diam., 1/6 each. "Focus" "Contrast" "Brilliance." "Brilliance—On-Off." "On-Off." "Volume." "Vol.-On-Off." "Tone." "Tuning." "Treble." "Bass." "Wavechange." "Radio Gram." "S.M.L. Gram." "Record-Play." "Brightness." Ditto, not engraved, 1/-



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THREE WAVEBANDS	FIVE VALVES
S. W. 16 m.—50 m.	LATEST MULLARD
M. W. 200 m.—556 m.	ECH42, EF41, EBC41.
L. W. 800 m.—2,000 m.	EL41, EZ40

12 month Guarantee. A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 8½in. × 2½in. Glass Dial 10 × 4½in., horizontal or vertical available. 2 Pilot Lamps. Four Knobs. Walnut or Ivory, aligned and calibrated. Chassis insulated from mains.

BRAND NEW £10.10.0 Carr. 4/6.
Matched 3-ohm speakers 8" 19/6, 10" 25/-

RECOMMENDED FOR ABOVE CHASSIS

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Collaro Autochanger RC531 for 78 R.P.M. 10in. and 12in. Records. Brand new in maker's boxes! High impedance, light-weight pickup with sapphire needle, will match any amplifier or radio. **£5.19.6** Less than half price.
Carr. 5/6.

Plessey

BARGAIN **£7.19.6**

Brand new Plessey 3-speed Autochanger Mixed Unit for 7, 10 and 12 in. Records. Twin Hi-Fi Xtal Head with Duopoint sapphire styles. Plays 4,000 records. Sprung mounting. Baseboard required 15½in. × 12½in. Height 5½in. Depth 9in. Super Quality. Post free. A.C. 200/250 v..

Walnut Veneered Playing Desk cut out ready for Plessey, only sold complete with Changer 10/6 extra.

B.S.R. MONARCH. 3-speed Motor and Turntable with selecting switch for 33, 45, and 78 r.p.m. records. 100-120 v. and 200-250 v. A.C. 50 cps. Also **B.S.R. MONARCH** Lightweight Pick-up with Acos Xtal turnover head, separate Sapphire stylus for L.P. and Standard records. **SPECIAL OFFER. THE TWO £4/15/6.** post 2/6.

AMPLION. 3-speed Single Record unit with Acos 37 Turnover Head, each Sapphire Stylus plays 2,000 records. Starting Switch Automatically places Pick-up on records, 7in., 10in., or 12in. Auto Stop. Baseplate 13 × 9½in. Height 5½in. Depth 1½in. Price £7/15/6. post free.

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For London, Midland and Northern Transmissions
Suitable for all T.V. makes. T.R.F. or Superhet.
Ready wound coils, two EF80 valves, all components, punched chassis, circuit diagram, wiring plans. COMPLETE KIT for mains operation 200-250 v. A.C. **£3/10/-.**

AS ABOVE less POWER PACK. Requires 200 v. 20 mA. H.T. 6.3 v. .6 a. L.T. **£2/5/-.**

Mains Transformer to above Spec. ...	10/6
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Punched and drilled chassis ...	3/9
Larger chassis for Mains Model ...	6/-
Teletron Coilset with plans ...	15/-
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Full plans and circuit details ...	6d.

T.V. PRE-AMP. (McMICHAEL). Will amplify output of your Band 3 Converter. Tuneable Channels 1 to 5. Midget size. High gain fringe model. B.V.A. Valve. Full instructions supplied READY FOR USE. (H.T. 200V., L.T. 6.3V., 3 amp. required.) **PRICE** 25/- each. BRAND NEW. **SPECIAL MAINS POWER PACK** for above, 25/- extra.

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Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg. No Sw. S.P.Sw. D.P.Sw. 3/- 4/- 4/9
EXT. SPKR. TYPE 3/-
COAXIAL PLUGS 1/- SOCKETS 1/-

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated ½in. dia. Stranded core.
Losses cut 50%... 9d. yd.
STANDARD ½in. Coaxial 9d. yd.
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BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω.
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ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2in. sides. 7 × 4in., 4/6; 9 × 6in., 5/9; 11 × 7in., 6/9; 13 × 8in., 8/6; 14 × 11in., 10/6; 18 × 14in., 12/6 and 18 × 16 × 3in., 16/6.

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BLACK CRACKLE PAINT. Air drying. 3/- tin.
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NEON MAINS TESTER SCREWDRIVERS, 5/6.

VCR97 TESTED FULL PICTURE £2

MULTICORE SOLDER 60/40. 18 s.w.g., 2d., 16 s.w.g., 4d. yard. 1lb. 2/6.
SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 4/3; K3/40 2.5 kV., 6/-; K3/45, 3.6 kV., 6/6; K3/50 4 kV., 7/3; K3/100 6 kV., 12/6;
MAINS TYPE. RM1, 125 v., 60 mA., 4/-; RM2, 100 mA., 4/9; RM3, 120 mA., 5/9; RM4, 250 v. 275 mA., 16/-.
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COILS Wearite, "P" type, 2/- each. Osmor Midget "Q" type adj. dust core, 4/- each. All ranges.
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F.M. TUNER COIL KIT 22/6. H.F. coil Aerial Coil, Oscillator Coil, two I.F. Transformers 10.7 Mc/s. Detector transformer and heater choke. With circuit.

CONDENSERS. New stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto 25 kV., 9/6; 100 pf. to 500 pf. Mica, 6d.; Tubular 500 v. .001 to .01 mfd., 9d.; .02 .1 1/-; .25 1/6; .3 1/9; .1/350 v., 9d.; .1/600 v. 1/3.

NEW ELECTROLYTICS. FAMOUS MAKES.

TUBULAR	TUBULAR	CAN TYPES
1/275 v. ... 2/-	100/25 v. ... 3/-	8+16/450 v. 5/-
2/450 v. ... 2/3	8+8/500 v. 4/6	1+16/500 v. 6/-
4/450 v. ... 2/-	16+16/500 v. 6/-	19+24/350 v. 4/6
8/450 v. ... 2/3	**CAN TYPES**	32+32/350 v. 4/6
8/500 v. ... 2/9	Clips ..... 3d.	32+12/450 v. 6/6
16/450 v. ... 3/6	16/450 v. ... 3/6	64+120/275 v. 7/6
16/500 v. ... 4/-	32/350 v. ... 4/-	64+120/350v. 11/6
32/500 v. ... 5/6	64/350 v. ... 5/6	100+200/275 v. 10/6
25/25 v. ... 1/9	100/275 v. ... 5/6	1,000+1,000/6 v. 6/6
50/25 v. ... 1/9	250/350 v. ... 5/6	
50/50 v. ... 2/-	500/12 v. ... 3/-	

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ amp., 13/6; 4 amp., 21/-.
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VALVE MANUALS I & II, 5/- ea. part.
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ACID HYDROMETER. New Ex Govt. Unbreakable. Packed in metal case 7 × 1½in. dia., 4/6.
TOGGLE SWITCHES. S.P.DT. ..... each 1/-
NUTS, BOLTS and WASHERS 12 of each, 2, 4 or 6BA ..... per packet 1/-

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A SMALL SELECTION FROM OUR STOCKS

All Boxed		1/6	New & Guaranteed	
2/6	5/6	EA50	6/6	10/6
1R5	6S8	954	6AL5	5Z4
1T4	9D2	2/6	6J5	12AT7
1S5	EF50	2X2	6K6	EBC41
185	Equiv.	EC148	6K7G	EBF89
3S4	8P61	KB34	EB91	ECH35
5Y4	8P41	3/6	HVR2	ECL80
6U4	EF92	3D6	(near)	ECH42
6AM6		6H6M		EF41
6AT6				EF80
6J7		7/6		EL41
6K8	7/6	6V6G	7/6	EZ40
6SL7	6BZ4	6X4	EL32	KT33C
6SN7	6BW6	6X5	HVR2A	MU14
6V6GT	6F6	807	PEN25	PL81
EBC33	6K7GT	EF39	U22	PY81
EF50	6K7M	VP23	VP23	PY82
Sylv. Red	12K8, 12Q7, 12K7, 25LA,25Z4			6Q7
EF91	Special Price — 2/6 — The Set			X79

2/6 BRAND NEW 2/6
SUB-MINIATURE VALVES.—WIRE ENDS—EX-DEAF AID APPARATUS R.F. PENTODES. .7SH7 FIL. TYPES DF70 AND CK505AX.

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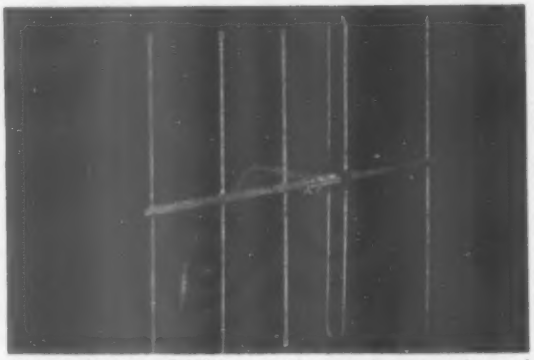
Pre-assembled for strength— convenience— ECONOMY



Light, robust as all Wolseys, with riveted construction and "flooded" junction box, this new 5-element array offers advantages you have never enjoyed.
Your wholesaler has stocks.

JY5W. 50/-

WALL MOUNTED

JY5MA for attachment to existing installations, with swan-neck arm. **50/-**
JY5 chimney lashed ... **65/-**

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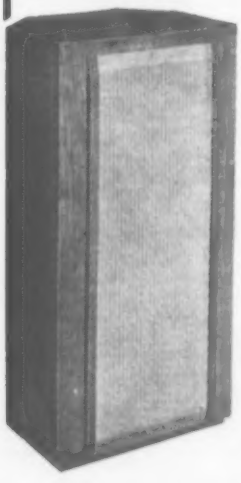

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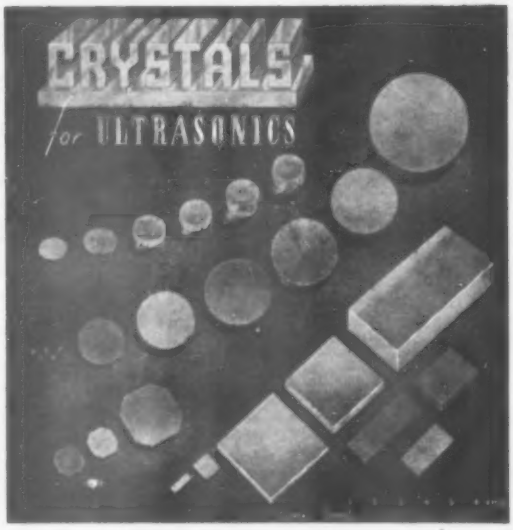

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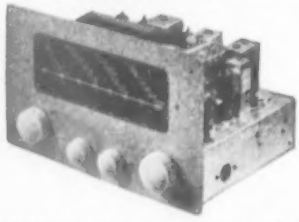

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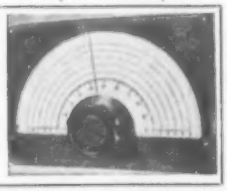

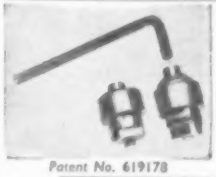

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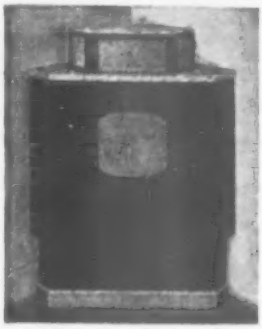

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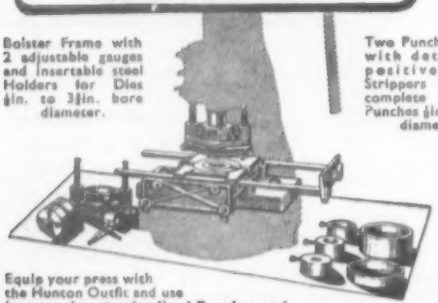

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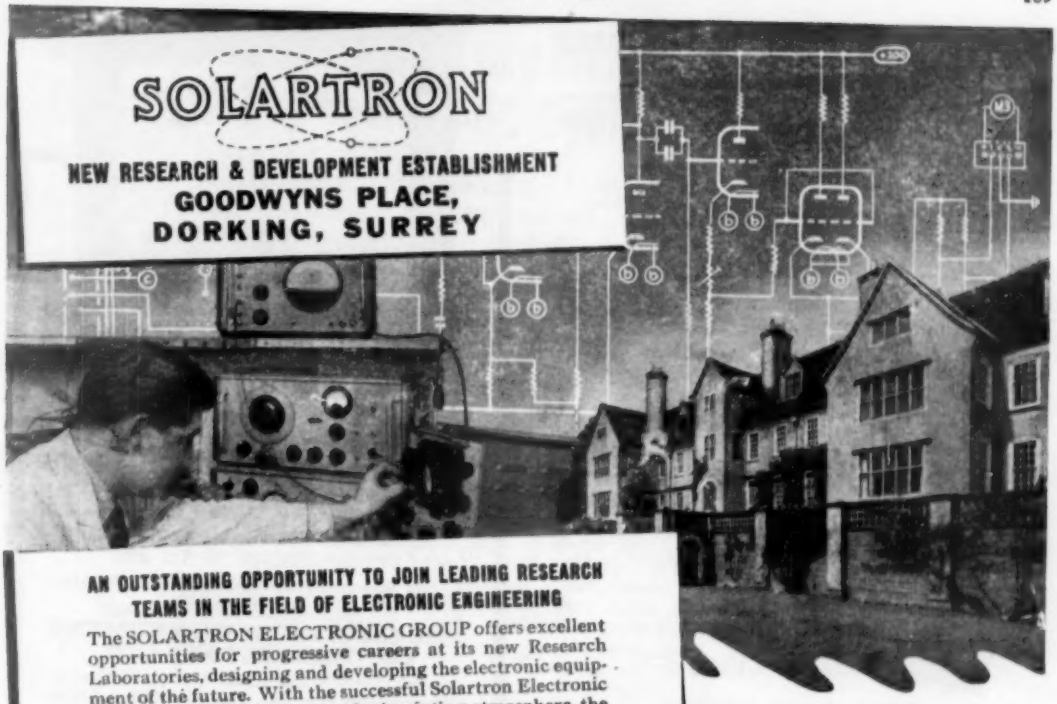

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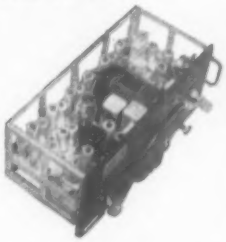

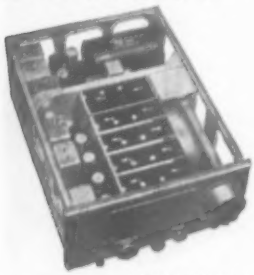

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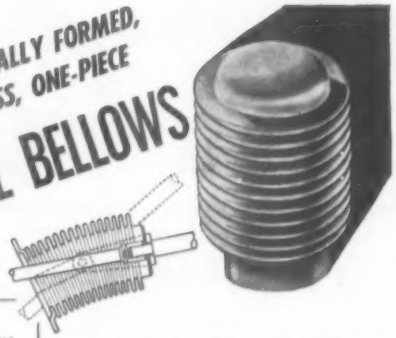

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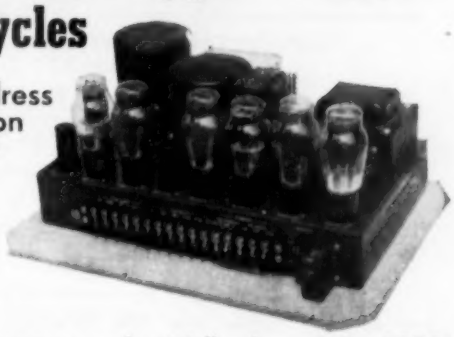

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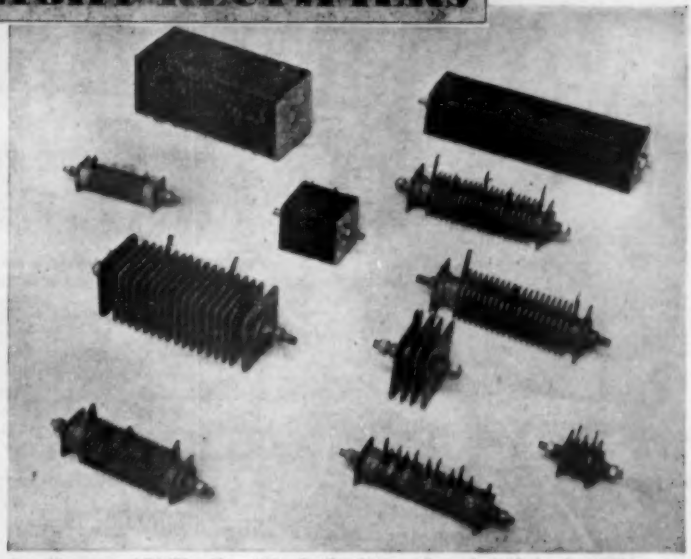

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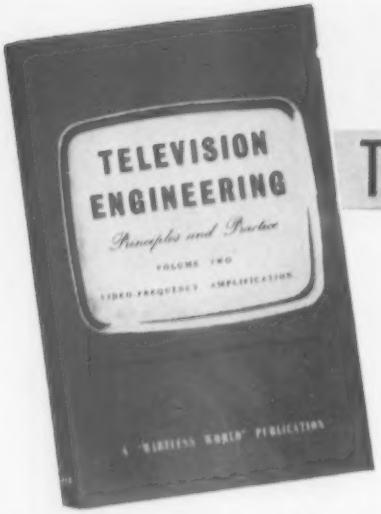

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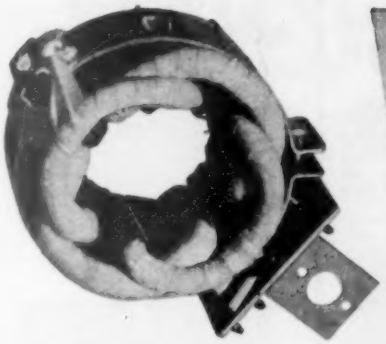

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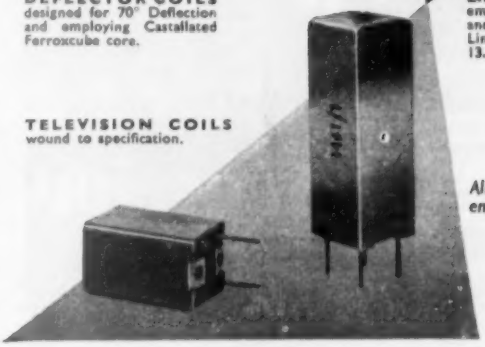

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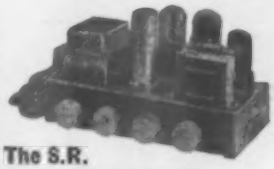

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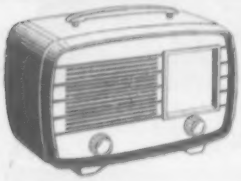

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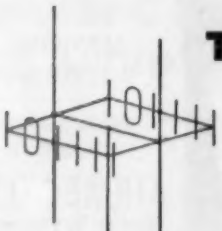

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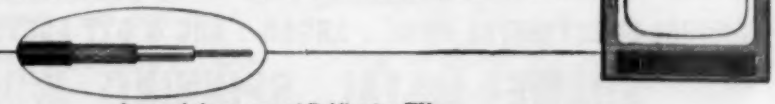

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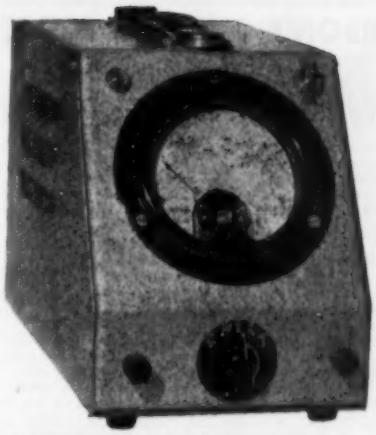

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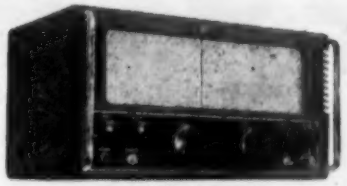

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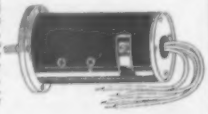

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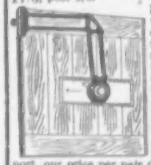

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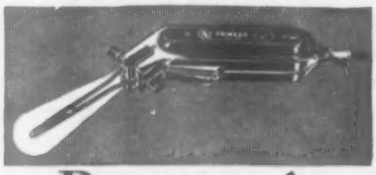

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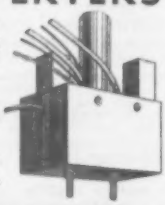

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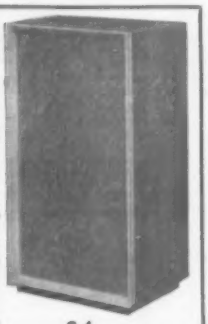

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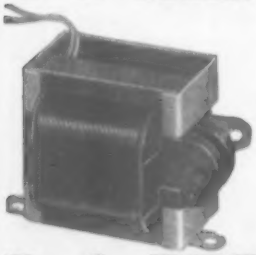

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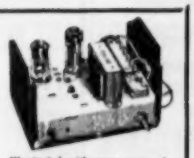

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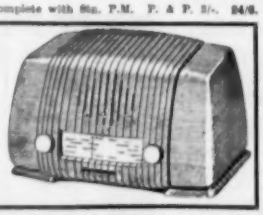

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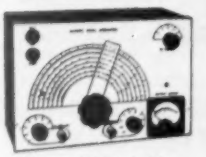

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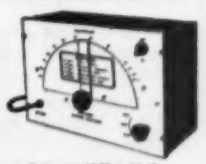

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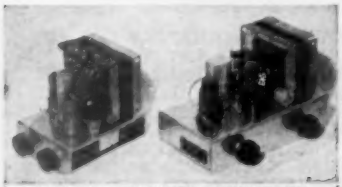

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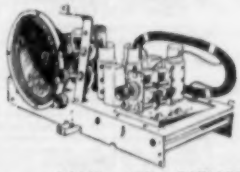

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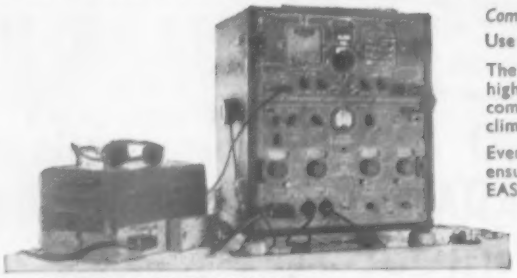

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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

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THE JTR/S1 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 13watts C/P each channel, 66gns; TWA/15 tape recording and reproducing amplifier, 13watts O/P, as described in the March "Wireless World," for Wearite and Collaro decks, 46gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type EB/1-15E high-fidelity amplifier, exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

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H.R.O. receiver, "S" meter, full set of coils, instruction manual; H.R.O. Power Pack; £24, perfect.
B. & M. Wire Recorder, super job, original cost over £100; bargain £25.
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ALL carriage paid, cash with order, satisfaction guaranteed.
H.P. RADIO SERVICES, Ltd., 55, County Rd., Liverpool, 4. [0047

HRO Ex's and coils in stock, also AR88, RCA88R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

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TANNOY 5watt pressure units complete with horn line transformer and bracket; £5.—Box 2399. [0096

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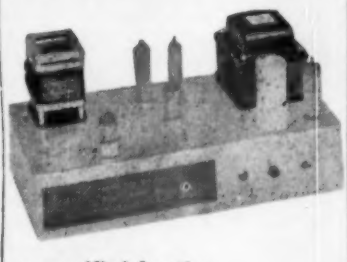

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COMPONENTS—SURPLUS AND SECONDHAND

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TELEVISION chassis, cadmium plated, steel, size 14×15×2¼in, complete with 13 valve holders (9-B9A Pax, 1-B9A Cer, 2-B7G Cer, 1-Int. Oct. amph), 20 various tag strip cut away for metal rect., line trans., etc.; 9/11 each, post paid.

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SCANNING coils, wide angle, with mounting lugs, 19/6, post paid.

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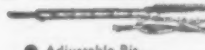

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LONDON COUNTY COUNCIL.

NORWOOD TECHNICAL COLLEGE. September: two Research Assistants (a) Chemistry or Biology; (b) Telecommunications or Physics; should hold suitable degree or equivalent qualifications; must undertake small amount of instructional work; the appointments are for two or exceptionally three years, with an allowance of £850 per annum (at present under review); application forms from Principal at College, Knight's Hill, S.E.27, returnable as soon as possible. (1119) [6095

WIRELESS operator mechanics required by FALKLAND Islands Dependencies Survey for service at isolated British bases in Antarctic. Must be able transmit and receive morse at 20 words a minute (plain language or code) and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men between 20 and 30 required, preferably single, of good education and high physical standard with genuine interest in polar research and travel, willing to spend 30 months under conditions testing character and resource.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2C/41540/W.F. [6071

APPLICATIONS are invited for pensionable posts as
EXAMINERS in the
PATENT OFFICE
TO undertake the official scientific technical and legal work in connection with Patent Applications. There is a small number of similar posts in the Ministry of Supply. Recruitment is by competitive interview; the Selection Board will sit at frequent intervals. CANDIDATES must be between 21 and 28 years of age during 1956 (up to 31 for permanent members of the Experimental Officer Class) and have first- or second-class honours degree in physics, chemistry, mechanical or electrical engineering, or mathematics. Candidates taking their degrees in 1956 may apply before the result of their degree examination is known.
EMOLUMENTS in London including Extra Duty Allowance for 45½-hour week on the scale £582 to £1,414 (men). Starting salary assessed according to periods of National Service and post-graduate experience, rising after 2 years' service to £751 (men) at age 24 or over. After 5 years' Patent Office service (3 or 4 years in exceptional cases) advance in scale to £1,099 (men). Good prospects of promotion to Senior Examiner £1,414 to £1,800 (men) with later opportunities of promotion to Principal Examiner and to some still higher posts. Women's salaries above £582 somewhat lower than men's but subject to annual upward adjustment under Equal Pay Scheme. Pay and conditions of service are under review. APPLICATION forms and further information from the Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting number S 128/56. [6052

WIRELESS Station Superintendent required for the
POSTS and Telecommunications Department, Gold Coast Local Civil Service, for two tours of 18 to 24 months in first instance. Consolidated salary scale £990 rising to £1,250 a year. Gratuity at the rate of £100/£150 a year. Outfit allowance £60. Liberal leave on full salary. Free passages. Candidates should preferably have served an apprenticeship in electrical or radio engineering and have had five years' subsequent experience in the manufacture, installation or maintenance of radio equipment. Candidates also eligible for consideration with at least eight years' engineering experience including a minimum of five years spent on above duties. Experience in two or more of following fields desirable; V.H.F. mobile and fixed link systems; H.F. communication system; frequency shift keying and teleprinter maintenance; V.H.F. and H.F. Cathode-ray direction finding; manufacture of light engineering projects; diesel engine generation; C. & G. Final Cert. in Telecommunications (Radio) an advantage.—Write to Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M3C/29100/WF. [6091

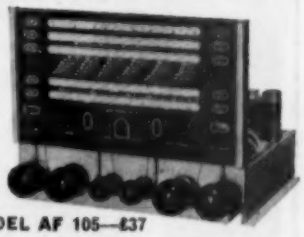
SCUNTHORPE HOSPITAL MANAGEMENT COMMITTEE.
LINCOLNSHIRE Radiotherapy Centre (50 beds).
PHYSICS Laboratory Technician. Duties concerned with application of physics to medical problems, maintenance and service of electrical equipment including high voltage X-ray sets and electronic equipment used in radioactive isotope work. Educational qualifications Inter B.Sc., ONC (Elec. Eng.) or equivalent, but practical experience considered in lieu of other qualifications. Salary scale £485×£15 (3)×£25 to £555, hours 45 weekly, holidays 4 weeks.—Application form from Group Secretary, War Memorial Hospital, Scunthorpe. [6051

METROPOLITAN Ear, Nose and Throat Hospital at St. Mary Abbots Hospital, Marloes Rd., Kensington, W.8.
HEARING aid technician required. National salary scales and conditions.
APPLICATIONS, giving full particulars, to Hospital Secretary (WW66) immediately. [6063

Armstrong

Three-in-one

AM/FM RADIOGRAM CHASSIS



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AM and FM Tuners and High Fidelity Amplifier on one compact chassis

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MODEL FC 48—£25.2.0.

For those who do not require the FM band but wish to maintain the quality of gramophone reproduction and AM reception, the FC48 can be recommended. It has substantially the same Amplifier and AM circuit specification as the 105.

The MISSING LINK—PABO-1

TAPE PRE-AMP AND ERASE UNIT

with built-in Recording Level Indicator and Monitoring facilities.

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WIRELESS SET 19 Mk. III. Frequency 2-8 Mc/s., and 235 Mc/s. Antenna output 6 watts. Systems A.1, A.2, A.3. Power source 12 v. battery with operating equipment for mobile or ground use.

AMPLIFIER R.F. No. 2. For use with Wireless Set No. 19 Mk. III. Boosts antenna output to 30 watts.

WIRELESS SET X28D. Frequency 4-8 Mc/s. in two switched bands. C.W. and frequency modulated and amplitude modulated R.T. Remote control facilities. Mobile or fixed station use. Power source 12. v D.C.

WIRELESS SET 62 Mk. II. Frequency range 1.6-10 Mc/s in two switched bands. Crystal controlled. For mobile use. Systems A.1, A.3, A.3—with operating equipment. Power source 12 v. D.C.

CRYSTAL CALIBRATOR No. 10 for use with Wireless Set 62.

WALKIE-TALKIE TYPE 38 (CANADIAN). Frequency range 6-9 Mc/s. Complete with accessories.

HANDY TALKIE SCR536. Frequency range 3.5-6 Mc/s. Complete with spare coils, etc.

TOR TRANSMITTER/RECEIVER STATIONS complete. Frequency range 1,500 kc/s-12,000 kc/s. Output 10 watts phone, 25 watts C.W. All operating equipment including Remote Control with loud-speaker and choice of Dynamotor Supply (12 v., 24 v., or 115 v.).

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Prices and further details on request.
Spare parts and associated equipment.

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Magslips Hunter Mk. used at 6/6 each.
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SENIOR Development Engineers (Electrical and Mechanical).
QUALIFIED engineers with experience on Relays Solenoids, Rotaries, Printed Circuit Connectors, etc., etc., required in a factory in East Anglia, engaged in manufacturing electrical components.
THE opportunity is exceptional for anyone with ability and initiative able to accept responsibility.
GOOD salary and excellent prospects.
APPLICATIONS in writing in strictest confidence, stating age, qualifications and salary required to Box 2396. [6096

SIERRA LEONE Government Posts and Telegraphs Department requires:
SIGNALS Staff for two tours of 18-24 months each either (a) with prospect of pensionable employment or (b) on temporary terms with gratuity at rate £100-£150 a year. Salary scales (including Expatriation Pay) as indicated. Commencing salary according to qualifications and experience. Outfit allowance £60. Free passages for officer and wife. Free passages for two children under age 19 or grant up to £150 annually for maintenance in U.K. Liberal leave on full salary. Candidates should be experienced M.F., H.F., V.H.F., V.H.F./D.F. and ancillary equipment. Preference for C. & G. Cert in Radio.
SIGNALS Officer (Aeradio) (M2C/41718/WF). Salary scale under terms (a) £1,272 rising to £1,442 a year or (b) £1,376 rising to £1,558 a year. Candidates should possess P.M.G. 1st Class Cert. or equiv. and should be able to control staff and organise traffic schedules.
ASS STANT Signals Officer (Aeradio) (M2C/41719/WF). Salary scale under terms (a) £797 rising to £1,257 a year or (b) £859 rising to £1,359 a year. Candidates should possess P.M.G. Cert. or equiv.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1., **State** age, name in block letters, full qualifications and experience and quote the reference number shown against the post applied for. [6060

CENTRAL ELECTRICITY AUTHORITY. SOUTHERN DIVISION.
FOURTH Assistant Engineers (Telecommunications) Technical Department.
APPLICATIONS are invited for the above appointments for which vacancies exist in the Swindon and Reading areas.
DUTIES will include the installation and maintenance of automatic telephone-type equipment including applications in telephony, supervisory and remote control systems. Knowledge of V.F. line signalling techniques and an acquaintance with electronic or V.H.F. radio would be an advantage.
TECHNICAL qualification to graduate standard of an appropriate Institution is desirable.
THE salary for these superannuable positions is in accordance with the N.J.B. agreement: A.X./CX: Grade 5 (£735-£900) or Grade 6 (£600-£825).
APPLICATION forms, obtainable from P. D. A. Oliver, Divisional Secretary, Central Electricity House, 111, High Street Portsmouth, should be returned by 11th July, 1956. [6092

TV/RADIO service engineer, fully experienced, good driver, pleasant Midland spa town.—Box 2544. [6069

TECHNICAL Writer, for Glasgow area, required by large precision instrument company.
APPLICANTS should be familiar with industrial instruments, although those with other electronic and electro-mechanical experience will be considered, and able to write technical service literature. The position can be progressive for the right man and the initial salary would be commensurate with experience.
APPLICATIONS, which can be made in the strictest confidence, should give full particulars of experience, age and salary required, and be addressed to Box 1856. [6014

A LABORATORY Assistant is required by progressive firm engaged in the manufacture of transformer cores.
APPLICANTS should be familiar with the use of electrical measuring instruments, and should have a good grounding in electromagnetics. Salary in accordance with qualifications and experience.
APPLY to the Chief Electrical Engineer, Telcon-Magnetic Cores, Ltd., The Industrial Estate, Chapelhall, Lanarkshire, Scotland. [6004

FIRST-CLASS TV engineer required to take charge of new workshop, must have Murphy and Bush experience; flat available; state remuneration required.—MODERN RADIO (CHELTENHAM), Ltd., 51, Clarence St., Cheltenham. [6070

DYNATRON RADIO, Ltd., require for their new and well-appointed development laboratories at Purse Platt, Maidenhead, the following technical staff:—
(1) SENIOR Radio Receiver Development Engineer with first-class qualifications and considerable experience in the design of advanced AM/FM receivers.
(2) SENIOR Development Engineer for nucleonic and electronic group.
EXCELLENT prospects and working conditions.—Apply Personnel Manager, Ray Lea Rd., Maidenhead, Berks. [6065

ENGINEER with wide experience of tape recording techniques required by well-known electronics company.—Please write, giving brief details of qualifications and experience, to Box 2098. [6081

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One or more A.B. Type "H" wafer switches to any desired contact specification.

Write for design chart and new comprehensive price list.

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Truvox Amplifier Switch Type 12119/B3 : 14/6d.

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RECORD PLAYERS! AMPLIFIED PLAYERS! GRAM MOTORS! AUTOCHANGERS! CABINETS!
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3-speed Gram Motors by well-known manufacturer. 100/125, 200/250 AC mains. 33½, 45, 78 r.p.m. and neutral by selector switch. 7 guines value! Our price £3/10/-.

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Available for the frequency ranges from 100 kc/s to 500 kc/s. and from 3 Mc/s. to 16 Mc/s. Gold electrodes applied by cathodic sputtering give permanence of calibration. Normal adjustment accuracy 0.01% Max. adjustment accuracy 0.003%.

Early delivery can be given of some frequencies, and we will be pleased to quote for your specific requirements.

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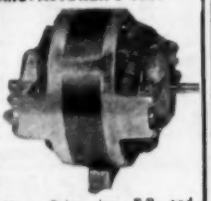
0.5	CP47N	0.001	CP49W
1.0	CP91N	0.002	CP49W
0.05	CP45S	0.005	CP45W
0.1	CP46S	0.01	CP45W
0.25	CP47S	0.1	CP47W

BRAND NEW TAPE RECORDER MOTOR AT HALF MANUFACTURER'S COST



Single phase motors suitable for tape recorders, radiograms, workshops, etc., etc. Has many uses. Reversible 200-230 v. 5in. oz. torque. 1,400 r.p.m. Capacitor start. Weight 4½ lb. Length overall 5in., spindle both ends. ⅜in. x ⅛in., ⅜in. x ⅛in. Price, inc. P.P. and capacitor, 55/-.

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H.T. 11,11.5v. in., out 365 v.-310 v., 30 mA.

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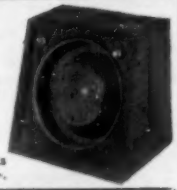

Impedance 7½Ω Handling cap. 8 watts price 29/6, post 3/-.

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Type 3,000. 100 ohm coil. 3 makes L. Duty contacts, 10/6. 175 ohm coil. 4 makes and 4 breaks, medium heavy contacts, 12/6. Both brand new. P.P. 1/- each.

HEAVY DUTY SLIDING RESISTORS

250 watts at 25 amps. Resistance 0.4 ohms. Suitable for charging board, etc.

1 ohm at 125 watts 12 amps.

Both brand new. Price 12/6. Post 3/-.

Quantity and Export Enquiries Invited. Callers also welcome

Open Monday to Friday 9.30-5.30. Sat. 9.30-1.

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DEPENDABLE—ALWAYS DEPENDABLE

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SENIOR Design Engineers.

REQUIRED for work on Television and allied equipment; good background in this field essential; good salary offered to suitable men.—Apply: Pilot Radio, Ltd., Park Royal Rd., N.W.10. [6097

INSTRUMENT Mechanics are required by the Industrial Group of the United Kingdom Atomic Energy Authority at Windscale Works, Sellafield, Cumberland.
DUTIES cover maintenance of instrumentation in reactors and chemical plants, also a wide range of specialized electronic equipment.
CANDIDATES must be experienced in industrial instrumentation or electronics either through apprenticeship or equivalent qualification.
TRAINING in maintenance of specialized instruments will be provided as necessary.
RATE of pay for a 44-hour week is 169/-. A Job Grading Scheme operates. The work is divided into three grades (A, B and C) and additional lead rates of 42/-, 30/- and 12/- respectively are paid.
MARRIED applicants, living outside the daily travel distance of the works, will be given consideration for housing within a reasonable period after recruitment.
APPLICATIONS, giving details of apprenticeship, training (including Forces training), qualifications and experience, to Senior Labour Manager, Windscale Works, Sellafield, Cumberland. [6044

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics drawing office at the Rugby Works of the B.T.H. Co., Ltd. Please apply in writing to:—CHIEF Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5811

DRAUGHTSMAN required for Electronics Division of Scientific Instrument Company, work involves preparation of chassis layouts, associated metal work, circuit diagrams, etc.—Apply to Box 2354. [6082

RADIO and TV receiver development engineer, graduate I.E.E., Brit. I.R.E. or equivalent, age 25-35, required for laboratory in North-West London area; salary £800-£1,000 according to ability.—Box 2356. [6083

CHIEF engineer (£1,500-£1,700 p.a.) required by an expanding instrument manufacturing company for the development of aircraft and industrial measurement and control equipment (electronic, pneumatic and mechanical). ALSO required are well qualified senior development engineers (£850-£1,200 p.a.)—one with experience of fluid flow, and senior draughtsmen (£14-£17 per week); housing assistance if required; pension scheme; pleasant town near coast and country; our own staff is aware of this vacancy.
SEND details of training and career (including present salary and employer) in confidence to Box 2050. [6054

ENGINEER required for development work on polystyrene film capacitors; position offers considerable scope for man with general experience in the capacitor industry particularly on the production side; own staff advised.—Write Box 2362. [6093

McMICHAEL RADIO, Ltd., Slough, Bucks, have vacancies from time to time for electronic engineers to be engaged on Government projects; those wishing to be considered are invited to write fully to the Chief Engineer, Equipment Division. [0196

A.B. METAL PRODUCTS, Ltd., require additional technical representatives, applicants must have previous experience in contacting leading manufacturers of radio, television and electronic equipment.—Apply Sales Manager, 17, Stratton St., London, W.1. [6057

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0236

SENIOR television development engineer with administrative experience required, capable of carrying out development projects with minimum supervision up to production stage; Kingston area.—Write, giving full personal details, stating salary required, Chief Engineer, Box 5942. [0123

WIRELESS technicians; salaries in range £511 (at age 25) rising to £641; opportunities of establishment and promotion; good knowledge V.H.F. essential; ability to drive an asset; write or call.—Director of Communications, Home Office, Whitehall, S.W.1 (Whi. 8100 Ext. 268). [6075

JUNIOR Technical Assistant required by London Chartered Patent Agents with a view to training for qualifying as a Patent Agent. Degree standard in electrical engineering desirable.—Write giving details of age, experience, etc., to Box 3140, c/o White's, Ltd., 72/76, Fleet St., E.C.4 [6035

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics Drawing Office of the British Thomson-Houston Co., Ltd., Blackbird Rd., Leicester.—Please apply in writing to Chief Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5643

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FM81/Mk11

F.M. V.H.F. TUNER completely stable drift free tuning. Volume control. Tuning indicator. A.V.C. Sensitivity better than 4 μV for 20 db quieting. 21 gns. Tax paid.

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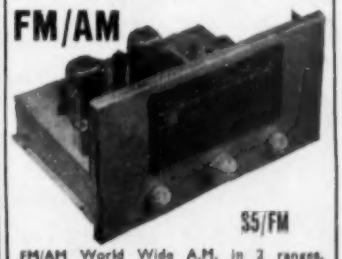
A.M. 9 band all wave tuner. 13 m.-570 m. Band spread, variable selectivity. Tuning indicator. Logging scale, delayed amplified A.V.C. Tropicalised. Sensitivity better than 2 μV for 250 m/v output. £46/4/- tax paid.

FM/AM



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FM/AM World Wide A.M. in 2 ranges. SSE/FM: 12.5 m.-37 m.; 35 m.-100 m.; 90 m.-250 m.; 190 m.-550.
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All tuners suitable for modern high quality amplifiers. Most tuners available with Escutcheons in Gold, Silver or Bronze.

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Both Cabinets could be supplied as a complete radiogram incorporating any of the following combinations of units:—
5 valve chassis, £12/10/-.
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9 valve AM/FM 26gns (incl. 2 speakers).
3-speed Garrard and Collaro autochanger, also BSR Monarch, £7/19/6, and Plessey Autochanger, £9/15/-. 8in., 10in., and 12in. Goodmans, Wharfedale, G.E.C., and W.B. Speakers.

Send for free illustrated catalogue of cabinets, chassis, autochangers and speakers, etc. H.P. can be arranged.

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ELECTRONIC engineer or Physicist for application research on ultrasonic flaw detector; the post involves contact with industrial users, interesting work and opportunities for advancement in a rapidly expanding field.—Write, giving details of age, experience, qualifications, salary required, etc., to Ultrasonoscope Co. (London), Ltd., Sudbourne Road, London, S.W.2. [5899

RADIO Mechanics wanted by large organization for overseas duties; tours abroad up to 2 years; candidates must be skilled men with good knowledge radio theory, single, medically fit and prepared to work anywhere in the world; basic U.K. salary £500 after training; overseas salary £75 per month plus all found.—Write Box WW.277, c/o 191, Gresham House, E.C.2. [6046

RADIO technicians required by International Aeradio Ltd., for overseas service; permanent and pensionable positions; inclusive salary from £894 per annum to £1,375 per annum, tax free, according to marital status; free accommodation; kit allowance; free air fares; generous U.K. leave.—Qualified candidates, to whom replies only will be sent, please write, quoting FT to Personnel Officer, 40, Park St., W.1. [0262

G. & J. WEIR, Ltd., Cathcart, Glasgow, have vacancies for electronic engineers to undertake research and development work, a university degree or equivalent academic qualification is required and experience in v.h.f. work is desirable but not essential; starting salary will depend on age and experience, superannuation scheme.—Applications should be sent to The Personnel Manager, G. & J. Weir, Ltd., Cathcart, Glasgow, S.4. [5942

DRAUGHTSMEN, designer draughtsmen and a checker are required by the electronics division to meet an expanding and varied programme of work; these are permanent posts affording an opportunity of broadening experience with excellent prospects and good commencing salaries.—If this advertisement interests you write for an appointment giving details of experience to Personnel Department (E.8), Murphy Radio, Ltd., Welwyn Garden City, Herts. [6056

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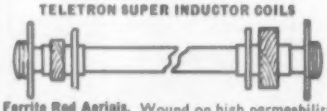

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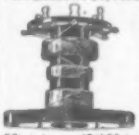

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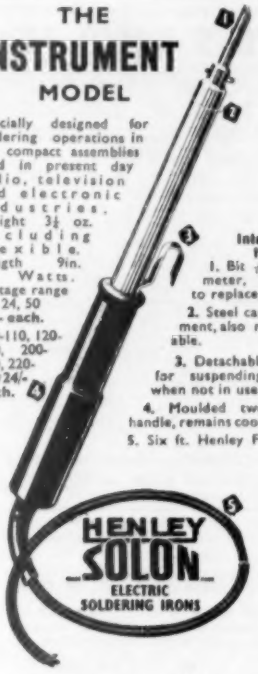

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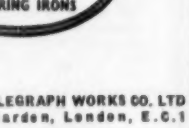

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AMBITIOUS man required by expanding electronic and transformer manufacturer in Home Counties; the right individual will be eligible for an important post on the management side at a later date; present duties will be to design and develop small transformers and if possible to materially assist with similar duties in connection with electronic engineering products; good salary; write giving full details of experience; details of earnings would be of assistance.—Box 2248. [6072

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TECHNICAL Assistants required in a mechanical test laboratory, applicants should have had some experience of instrumentation and a knowledge of strain gauge techniques would be useful, the work is of a varied nature, concerning environmental testing; experience of testing and recording experimental results could be more important than knowledge of electronics.—Apply, stating age and experience, to Personnel Manager, The General Electric Co., Ltd., Brown's Lane, Coventry. Ref. R.G.O. [5963

QUALIFIED Electronic Engineer wanted by large organization for training as overseas project leader; must be single, medically fit and prepared to take charge of technical supervision, administration, organization and liaison on overseas contracts; age group 27 to 33. Qualifications: B.Sc degree or membership of appropriate institute, H.N.C.C. & C. final in telecoms. or equivalent plus at least 3 years' experience in some branch of industrial/communications electronics. Home salary in the range of £650 to £800 and overseas £1,100 to £1,400 plus all found.—Write Box WW.278, c/o 191, Gresham House, E.C.2. [6045

THE GENERAL ELECTRIC Co., Ltd., has a vacancy in the editorial section of its Publicity Organization for a writer capable of preparing information for the national, technical and trade press, conducting active press relations and producing literature. This is a post which offers scope to a technical journalist and/or University graduate with an interest in the wide field of activities covered by the company, but principally in electronics, radio and television. Applications should include full details of education, age, qualifications experience and salary required, together with specimens of written work, and should be addressed to the Staff Manager, The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. [6066

ELECTRONIC Engineers are required by the Equipment Engineering Department of Westinghouse Brake & Signal Co., Ltd., at Chippenham, Wiltshire, to take part in the development and subsequent engineering design for production, of new control systems, employing electronic techniques, for traffic control on British & Overseas Railways. The scope of the work will range from practical experimental work to the issue of design instructions on which will be based manufacturing drawings, together with the compilation of manufacturing specifications and descriptive pamphlets. In addition co-operation will be required with Production Engineers during manufacture of first-off equipments in the Company's Chippenham Works.
POSITIONS are available for University graduates with a good telecommunication Degree in Electrical Engineering. Some experience with transistor techniques is required, together with experience of line communication systems employing audio and carrier frequencies. A knowledge of computing techniques would also be an advantage but is not essential.
THE salaries will be determined by age, qualifications and experience; the Company operates a pension scheme and a 5-day week.
FOR further information write, giving age and full particulars, to Personnel Superintendent, Westinghouse Brake & Signal Co., Ltd., Chippenham, Wilts, quoting ref EQUIP/N/Q. [5975

WAR OFFICE requires an Experimental Officer (male) at Royal Military College of Science, Shrivenham, Berkshire, in Engineering Physics Branch of Department of Instrument Technology. Degree in Engineering or Physics or H.N.C. in Electrical or Mechanical engineering, or equivalent qualifications, and experience in instrumentation, especially servo-mechanisms or computing. (Knowledge of guided weapon control techniques highly desirable.) Inclusive salary: £781–£965. Starting pay according to age and experience. Age at least 26, preferably under 51 years. Prospects of permanency.—Full particulars and application forms from M.L.N.S., Technical and Scientific Register (E), 26, King St., London, S.W.1, quoting reference D.85/56. Closing date July 17, 1956. [6076

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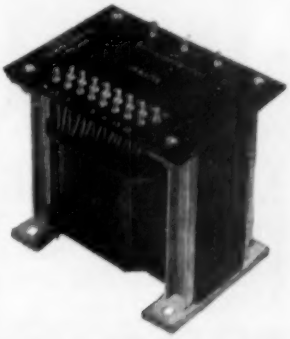

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AIR MINISTRY require civilian radio technicians at R.A.F. Handforth; applicants should possess sound knowledge of radio and radar; employment subject to passing entry test, offers good prospects of becoming pensionable, inclusive annual salary £414 at age 19 to £551 at 25 and over, rising to maximum of £641; five-day week of 44 hours.—Applications, stating age, qualifications and experience, to Commanding Officer, No. 61 Maintenance Unit (R.T. 11), R.A.F., Handforth, Grove Lane, Cheadle Hulme, Stockport, Cheshire. [5696

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D.S.I.R. require Experimental Officers and Assistant E.O.s at Radio Research Station, Datchet, Berks. to (i) assist in radio research (Ref. A 224/6A) and (ii) prepare abstracts of scientific and technical articles on radio research and development (Ref. A 225/6A). Quals. in Physics or Electrical Engineering, min. G.C.E. (Advanced level) in two scientific subjects, or equiv. Over 22 pass degree, H.N.C. or equiv. generally expected. Experience in radio research or development, or communications an advantage. For posts (ii) ability to read technical French and German an advantage. Posts (i) offer opportunities for service abroad. Salary E.O. £781-£968, A.E.O. £528 (at 18)-£705. Slightly less for women but subject to improvement under Equal Pay Scheme. —Forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting appropriate reference [6090

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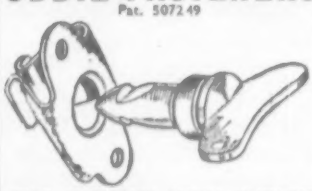

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	Page
A.A. Tools	135
Acoustical Mfg. Co., Ltd.	16
Adcola Products, Ltd.	18
Advance Components, Ltd.	45, 134
Aerialite, Ltd.	58
Aero Research, Ltd.	23
A.G. Engraving	140
Airmec, Ltd.	7, 118
Alpha Radio Supply Co., The	101
Altham Radio Co.	118
Amassador Radio & Television	54
Ampiex Appliances (Kent), Ltd.	126
Anders Electronics, Ltd.	108
Antex	114
Antiference, Ltd.	25
Appointments Vacant 107, 109, 128, 150, 151, 152, 153, 154, 148,	149
Arcolectric Switches, Ltd.	42
Ardente Acoustic Laboratories, Ltd.	40
Ariel Sound, Ltd.	84
Armstrong Wireless & Television Co., Ltd.	42, 141
Aspden, W.	155
Automatic Coil Winder & Electrical Equipment Co., Ltd., The	I
Automatic Coil Winder & Electrical Equipment Co., Ltd., The	16C
Automatic Telephone & Electrical Co., Ltd.	41
Bates Surplus Stores	134
Beamish, V. W.	146
Bell, John L. Croyden	44
Belling & Lee, Ltd.	69, 104
Bel Sound Products, Ltd.	130
Benson, W. A.	140
Berry's (Short Wave), Ltd.	106
Bird, S. S. & Son, Ltd.	8
Birmingham Sound Reproducers, Ltd.	64
B. K. Partners, Ltd.	104
Blickvac Engineering, Ltd.	70
Bradmatic, Ltd.	102
Britain, Chas. (Radio), Ltd.	129
British Communicating Corpn., Ltd.	57
British Distributing Co.	140
British Institute of Engineering Technology	142, 146
British Insulated Callender's Cables, Ltd.	14
British National Radio School	125
British Physical Laboratories	84
British Sarozal, Ltd.	126
British Thomson-Houston Co., Ltd.	53
Brookes Crystals, Ltd.	104
Brown, S. G., Ltd.	98
Bulgin, A. F., & Co., Ltd.	Edit. 351
Bull, J., & Sons	113
Bullers, Ltd.	50
C. & G. Kits	123
Candler System Co.	134
Cathodeon Crystals, Ltd.	22
Cementation (Muffelite), Ltd.	51
Champion Products	140
Chapman, C. T. (Reproducers), Ltd.	145
Cinema Television, Ltd.	49
City Sale & Exchange, Ltd.	108
Classic Electrical Co., Ltd.	65
Clyne Radio, Ltd.	94, 95
Concord Electronics	60
Cosmocord, Ltd.	68
Cossor, A. C., Ltd.	15
Coventry Radio	131
Crane Packing, Ltd.	103
Crosfield, J. F., Ltd.	158
Daly (Condensers), Ltd.	54
Davies, A., & Co.	146
Davis, Jack (Relays), Ltd.	114
De La Rue, Thomas & Co., Ltd.	59
Denco (Clacton), Ltd.	58
Dependable Radio Supplies	143
Direct T.V. Replacements	83
Dixon, L., & Co.	140
Domestic Direct Sales, Ltd.	87
Drake, F. W.	152
Drayton Regulator & Instrument Co., Ltd.	110
Dubilier Condenser Co. (1925), Ltd.	11
Duke & Co.	135
Dulci Co., Ltd., The	46
Duode Natural Reproducers	138
Edison Swan Electric Co., Ltd. Cover ii, 19, 72,	121
Eden Electric, Ltd.	48
E.I.R., Ltd.	131
E.K.E.	131
Electro-Acoustic Developments	132
Electro-Acoustic Industries, Ltd.	21
Electro-Methods, Ltd.	22
Electro-Winds, Ltd.	126
Electronic Instruments (H'ton) Ltd.	110
Electronic Precision Equipment	80, 81
E.M.I. College of Electronics	71
E.M.I. Electronics, Ltd.	72
E.M.I. Institutes	17, 76
E.M.I. International, Ltd.	52F
English Electric Valve Co., Ltd.	55
Enthoven Solders, Ltd.	9, 24
Eta Tool Co. (Leicester), Ltd.	102
Excel Sound Services, Ltd.	131
Fairey Aviation Co., Ltd.	17a
Ferranti, Ltd.	12
Filmer, J. T.	135
Fogie, W. & G., Ltd.	44, 122
Franks, H.	119
Fringevision, Ltd.	122
Frith Radiocraft, Ltd.	130
Furzehill Laboratories, Ltd.	61
Galpins	136
Gardners Radio, Ltd.	61
Garrard Engineering & Mfg. Co., Ltd.	4
Gee Bros., Radio, Ltd.	120
General Electric Co., Ltd.	23
Gilfillan, R., & Co., Ltd.	142
Gillone Electric, Ltd.	115
Gilson, R. F., Ltd.	147
Gladstone Radio	122
Glaser, L., & Co.	151
Goldring Manufacturing (Gt. Britain), Ltd.	54
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Hall Electric, Ltd.	6
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Harris, D.	156
Harris, P.	135
Hartley, H. A., Co., Ltd.	56
Hatfield Radio	124
Hatter & Davis, Ltd.	140
Henley's, W. T., Telegraph Works Co., Ltd.	145
Henry's (Radio, Ltd.)	127
Hilger & Watts, Ltd.	38
Hivac, Ltd.	16A
Holleys Radio	158
H.P. Radio Services, Ltd.	121
Hughes, F. A., & Co., Ltd.	52
Hunton, Ltd.	105
Iliffe & Sons, Ltd.	100, 114
International Correspondence Schools	82
Jason Motor & Electronic Co.	108
J.P. Electric, Ltd.	116
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Keyswitch Co., The	52
Kolectric, Ltd.	100
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Lasky's Radio	88, 89
Leak, H. J., & Co., Ltd.	79
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Lewis Radio Co.	144
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Marconi's Wireless Telegraph Co., Ltd.	21, 74
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Mullard, Ltd.	52B
Multicore Solders, Ltd.	Cover iv
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Northern Polytechnic	131
Northern Radio Services	53
Nu-Swift, Ltd.	155
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Parsonage, W. F., & Co., Ltd.	131
Partridge Transformers, Ltd.	137
P.C.A. Radio	112
Pearce, T. W.	147
Pitman, Sir Isaac, & Son, Ltd.	135
Plessey, Ltd.	51
Post Radio Supplies	150
Power Controls, Ltd.	20
Premier Radio Co.	62, 63
Proops Bros., Ltd.	92, 93
Pullin, R. B.	149
Pye, Ltd.	15
Pye, W. G., Ltd.	52
Quartz Crystal Co., Ltd.	142
Radio & Electrical Mart, The	126
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Sangamo Weston, Ltd.	78
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Service Radio Spares	122
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Siemens & Halske	2E
Sifam Electrical Instruments Co., Ltd.	130
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Solartron Electronic Group, Ltd.	109
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Specialist Switches	142
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Spencer-West	144
Stamford, A. L.	128
Standard Telephones & Cables, Ltd. 30, 67,	75
Standard Telephones & Cables, Ltd.	32A
steatite Insulations, Ltd.	52
Stern Radio, Ltd.	90, 91
Stewart Transformers, Ltd.	116
Stratton & Co., Ltd.	4
Sutlex, Ltd.	55
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Sugden, A. R. & Co. (Engineers), Ltd.	52E
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Telegraph Condenser Co., Ltd. Cover	iii
Telegraph Construction & Maintenance Co., Ltd.	117
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Teletron Co., The	144
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T.R.S.	123
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Verdik Sales, Ltd.	134
V.E.S. Wholesale Services, Ltd.	124
Vitality Bulbs	122
Vortexion, Ltd.	77
Walmore Electronics, Ltd.	112
Watts, Cecil E.	150
Wayne Kerr Laboratories, Ltd., The	2
Webber, R. A., Ltd.	128
Webb's Radio	111, 150
Westinghouse Brake & Signal Co., Ltd.	113
Westwood, L.	124
Weymouth Radio Mfg. Co., Ltd., The	112
Wharfedale Wireless Works	84, 120
Whitaker, H.	120
White, S. S., Co., of Gt. Britain, Ltd., The	36
Wilkinson, L. (Croydon) Ltd.	96
Wilson, Ronald	142
Wolsey Television, Ltd.	104
Wright & Weaire, Ltd.	5
Young, C. H.	126
Z. & I. Aero Services, Ltd.	136

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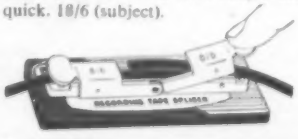

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